

August 8, 1960

Aviation Week

and Space Technology

**Avionic Industry
Probes Nuclear
Pulse Radiation**

NASA Wind Tunnel
Tests GE Lift-Fan

75 Cents

A McGraw-Hill Publication



Lift-Fan Tests Show VTOL Potential

LIQUID HYDROGEN PROPULSION

by Aerojet

The largest known liquid hydrogen rocket engine—delivering well over 100,000 pounds thrust—will first operate at Aerojet General's Liquid Rocket Plant near Sacramento and is now under further development.

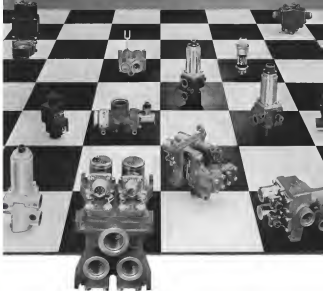
This important milestone in propulsor progress was started through Aerojet's development of a large liquid hydrogen pump. It constitutes the last technological breakthrough required for the development of very high thrust liquid rocket engines for astronautical research vehicles and the placement of large payloads in orbit.

Aerojet-General
CORPORATION

Plants at Azusa, Ontario, San Dimas and near
Sacramento (California, England, Maryland)



Engineers, scientists—investigate outstanding opportunities at Aerojet



Problem-solving hydraulic valves a 17-year specialty at Hydro-Aire

Thousands of models—more than 111,000 hydraulic valves, pumps, and controls since 1948. That's a lot of problems solved, for a lot of designs and project engineers involved in airborne hydraulics. Have we helped you yet? There's a good chance we have the answer to your problem readily available. If not, our accumulated experience and complete facility give a head start toward on-time delivery. Try us. Send Hydro-Aire your specifications for a prompt quote. And, write on your letterhead for a free copy of our catalog.

Engineers: write D. B. Nachman, Chief Engineer, regarding career opportunities at Hydro-Aire



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Reeves
INSTRUMENT CORPORATION

proudly presents the

ZERO-ONE



100-360
Integrating Steady Gyro

CONSISTENT RELIABILITY

In production quantity with life float gyro

with trimmed drift rate of

ONE HUNDREDTH DEGREE per HOUR

Designed-in reliability and the most precise production techniques have combined to produce the new ZERO-ONE Gyro. The first in a new series of IFG-330 integrating float gyro, the ZERO-ONE is a proud achievement in the long line of gyro developments by REEVES.

The combination of high reliability and extreme accuracy make the ZERO-ONE Gyro the ideal choice for guidance and stabilization systems where guaranteed performance is paramount.

For complete specifications, write for data file 708

QualMed engineers, making outstanding opportunities in these advanced fields, are wanted to get in touch with us.

REEVES INSTRUMENT CORPORATION

A Subsidiary of Dynamics Corporation of America • Bessett Field, Garden City, New York 11530

See our display at NEICON — Booth #107

TECHNICAL SPECIFICATIONS

Torsion Drift Rate: 0.01 degrees/hr
Angular Momentum: 300,000 cgs. units
Damping: 300,000 cgs. units
Nominal Signal Generator Sensitivity: 10 mv/cv @ 30 mv. 400 cps
Torque Generator Sensitivity Range: 0.05 to 5.0 degrees/cv/mv
Time Constant: As low as 0.4 msec.
Axis Stiffness: 9.4°/in./g
Amplification: 0.005°/in./g
Overload: 1.0 in. ± 2.0 in.



AVIATION CALENDAR

- Aug. 18-24-15 Annual Congress, Inter-national Automobile Physicians, Royal Institute of Technology, Stockholm
- Aug. 16-18—Fourth Annual To Service Con-ference on Biological Effects of 14-Me-neutron Radiation, New York University Postgraduate Medical School, NYU Medical Center, N.Y.C. Sponsors: Air Research and Development Command
- Aug. 18-19—Second International Sympo-sium on Subacute and Space Medicine, Laboratories of Aviation and Naval Medi-cine, Karolinska Institute, Stockholm
- Aug. 18-20—Electronic Packaging Sympo-sium, University of Colorado, Boulder
- Aug. 18-21-1968 Congress, Engineering Conference, University of Colorado
- Aug. 23-24—Western Electronic Show & Convention, Los Angeles Western Sports Area, Los Angeles, Calif.
- Aug. 25 Sept. 5-1968 National Air Rally, Municipal Airport, Orange, Mass. Spon-sors: National Aeronautics Assn.
- Sept. 1-4—Symposium on Rocket and Solid-fuel Instrumentation, Society of Aero-nautics Technology and 8-9th, Develop-ment Society, London, England
- Sept. 4-5—Guidance, Control Course, Appli-cation Forum, Littelford Airport, Cleveland
- Sept. 11-12-1968 Proceedings, Physics Dis-cussion and Exhibition, Society of British Aircraft Construction, Farnborough, Eng-land
- Sept. 17-18—First Antarctic Control Confer-ence, Massachusetts Institute of Tech-nology, Cambridge, Mass. Sponsors: International Society of Astronautics, American Society of Mechanical Engineers, Ameri-can Institute of Electrical Engineers, In-stitute of Radio Engineers, American Institute of Chemical Engineers
- Sept. 23-24-1968 Eastern and Western Symposia, Aeronautics Corp., Milledgeville, N.J.
- Sept. 24-26-1968 National Convention, OPA Club of America, Tamar Hall, Coats, Dallas, Tex.

(Continued on page 6)

AVIATION WEEK and Space Technology August 5, 1968 Vol. 72, No. 4

Get the very best in aviation news in Space Technology. This week's edition contains the latest news on the space program, including the Apollo 7 mission, the Skylab mission, and the upcoming Apollo 8 mission. It also features articles on the development of new aircraft, the use of computers in aviation, and the latest in space exploration.

For more information and complete operating specifications, write or wire SM/I today. Address your inquiry to Stanley M. Ingross, Capabilities Engineer.

Engineering notes from the

SM/I REPORTER

BY STANLEY M. INGROSS, Capabilities Engineer



Report No. 8 WR 2000 Computer Module Test Set

Our new WR 2000 test set automatically tests "black box" mod-ules having electrical inputs and outputs. It is presently being used to test modules of several different computer systems. Input-coupled functions in the modules are simulated from a 5-phase radio transformer and are automatically programmed through a unique programming retractor, which provides the WR 2000 with the versatility required to test a wide range of airborne-analog computer systems. Output transfer functions of the mod-ules are automatically read out through a 4-phase transformer. Up to 30 input command functions and up to 10 output transfer functions for each input command are possible for each module. This SM/I test set can be operated by actively unpowered personnel, and its over-90% accuracy of measurement ranges from 0.05 to 0.25% of full scale, depending on type of test performed.

Physical Characteristics

Size	4" L x 15" W x 20" H — table top
Weight	200 lbs.
Power Requirements	
115 V 40 cps	300 watts max
115 V 60 cps	750 watts max
230 V 60 cps	150 watts max
Airflow	0.02 to 0.25% full scale



For more information and complete operating specifications, write or wire SM/I today. Address your inquiry to Stanley M. Ingross, Capabilities Engineer.

SM/I

REINVENTOR/ANALYST/WRG
Los Angeles Division
10505 Aviator Boulevard
Newbury, California

VAP-AIR cooling effect detector

Senses the actual cooling effectiveness of the air being delivered even electronic components regardless of volume, density or temperature delivered.

A simple and proven device — lightweight, positive, accurate... under all conditions.



Are you sure your electronic components are receiving sufficient cooling?



VAP-AIR — SPECIALISTS IN AIRCRAFT TEMPERATURE CONTROLS FOR NEARLY 20 YEARS

Extensive experience and a complete line of sensors, electronic controls and precise voltage regulation, electromagnetic and electro-mechanical valves, advanced on-line valves and regulators, electronic power controllers and heat exchanger equipment — for aircraft, missiles and ground support.



for complete technical information
and applications write:

VAP-AIR AERONCA PRODUCTS DIVISION
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Please send me Bulletin Number 888 on the
VAP-AIR Adjustable Cooling Effect Detector

NAME _____
FIRM _____
ADDRESS _____
CITY-STATE _____

FIERY BIRTH OF A SUPERSONIC SPEED BRAKE... AT 2000° F.



AERONCA designs, tools, produces and tests advanced brazen honeycomb structures

In the production of exotic high-temperature air weapon components, there is no substitute for actual experience. That is why Aeronca... with production records on several thousand brazed stainless steel honeycomb sandwich assemblies... is one of the recognized leaders in this highly specialized field.

And to meet the growing requirement for complex high-temperature structures, Aeronca has evolved a fully integrated facility for designing, tooling, producing and testing all types of brazed honeycomb sandwiches. This special facility includes more than 65,000 square feet of plant area and the most advanced production and inspection equipment available today. Brazed structures up to 14' x 24' can be produced at volume at present.

Whatever your requirements, Aeronca's experience and capabilities can assure you of uniform quality, on-schedule deliveries and the lowest overall cost consistent with reliability and performance specifications. Our customers will verify that Aeronca performs results... not claims!

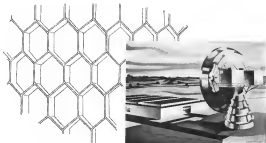


This complex speed brake for a new air weapon system illustrates Aeronca's advanced capabilities. Photo at top shows one of three units emerging from furnace after brazing cycle (test temp. 2000°F).



We have openings for qualified R&D Engineers with Bachelor's Degree, M.S. or Ph.D. in Mechanical Engineering.

AERONCA
manufacturing corporation
1716 DETROIT AVENUE ROAD • MIDLANDTOWN, OHIO



FAIRCHILD

*for high-strength, low-weight
honeycomb sandwich construction*

Fairchild Aircraft & Missiles Division offers industry a unique capability in honeycomb sandwich design and construction. Typical of such competency is that it is a contract award to Fairchild by the Raytheon Company for the design and manufacture of a giant parabolic reflector for use in the fire-stary-high radar system designated "Pawdowh", a project sponsored by the Advanced Research Project Agency, Department of Defense, for tracking and identification of intercontinental ballistic missiles. Fairchild



will also fabricate the 36x30x40 ft. room complex which houses more than 80 tons of electronic equipment. Due to the critical dynamic and stringent lightweight requirements, aircraft design and fabrication principles will be utilized.

The reflector, to weigh only 13,000 pounds, will be built of aluminum and its reflector surface will be made of honeycomb panel material which will require the extensive use of such Fairchild capability —

loading. The use of honeycomb paneling impacts rapidly, reduces weight and cost, and simplifies testing and replacement.

Raytheon officials state that Fairchild's ability to maintain the rigidity and tolerance requirements to hold the total weight of the reflector to 13,000 pounds, represents a major technical break through in the field of large antenna structural design.



Write for complete information on the many ways Fairchild honeycomb sandwich construction can be of assistance to you.



FAIRCHILD AIRCRAFT & MISSILES DIVISION
Fairchild Engine & Airplane Corp. • Hagerstown, Maryland

A New Galaxy in Electronics and Aerospace Activity

Ling-Altec Electronics, Inc.

and

Temco Aircraft Corporation

Join Forces as



Ling-Altec has attained remarkable growth in superpower electronics communications (radio, radar and sound), vibration and environmental testing equipment for missiles and high-performance aircraft, closed-circuit television, stores and other sound systems.

Temco has won an enviable position among the nation's Top 500 corporations as a producer of aircraft, missile and propellant systems and components, many special electronic devices and the famous round 3- and 5-dimensional radar plotting display installations.

We take pleasure in announcing this new focus in the electronics and aerospace industry. The combined skills, facilities, management talent, financial capability and research programs establish Ling-Temco Electronics, Inc. as a strong, integrated corporation whose primary interest is the development and production of electronic and aerospace systems.



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THE CALADINE COMPANY, INC., DIVISION
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The art of precise detection

Dominating its environment is a Sperry Area Search Radar—one of a network which will strengthen America's Continental Aerial Coastal and Warning System. Twenty-four hours a day the year around, these giant radars stand guard searching the skies for possible "hostiles."

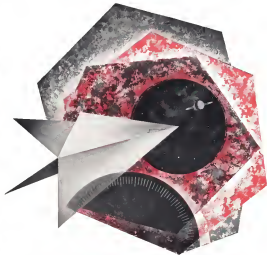
This is one of many advanced Sperry radar systems. Others are tracking and guidance radars for the Navy's Tether and Tilted missiles . . . airborne navigation and weather radars for the Air Force . . . portable and reliable tactical early warning radars for the Marine

Corps . . . key battlefield surveillance radars for the Army foot soldier. And in commercial shipping, Sperry radars are guiding all types of vessels from the luxury ocean liner to the harbor tug.

Sperry capabilities in radar and component technology in such fields as microwave instrumentation, kinetics and traveling wave tubes, ferrite devices, semiconductors and many other specialized fields related to radar continue to advance the art of precise detection . . . and direction. General offices: Great Neck, New York.



SPERRY



LIQUIDOMETER instrumentation capability

. . . offers the dependability of long experience in both electronic and electromechanical instrument control systems, gives the versatility of original designs.

If you are concerned with space vehicles, aircraft, ground support units, or test facilities—you are invited to investigate Liquidometer.

A new booklet outlining our capabilities is available on request.

THE LIQUIDOMETER CORP.

DEPT. 1, 1000 BROADWAY, NEW YORK

Since 1920



of proven quality



NEW **VICKERS**

Variable Displacement Hydraulic Pumps with MAXIMUM HP/LB RATIO

Model Series	Engagement in in./rev	GPM		Weight lb.	HP/LB	
		Rated	Max.		Rated	Max.
PV005	066	18,200	12,500	2.8	4.66	9.12
PV012	180	14,500	32,000	4.5	4.46	3.68
PV024	367	11,000	8,000	6.9	4.53	3.13
PV035	600	10,000	8,000	10.2	4.33	3.46
PV062	906	8,900	7,000	14.0	4.46	3.49
PV104	1,506	3,500	5,800	19.0	4.65	3.59
PV188	2,500	6,900	5,100	26.0	4.60	3.60

*This is hydraulic output horsepower at 3000 psi

The above table is important to anyone concerned with the selection of hydraulic pumps for future air or space vehicles. Note particularly the horsepower-to-weight ratios for built-in rated and limited life speeds. These are the highest ratios available on the line.

But hydraulic pumps are only one of many advantages offered you by the new Vickers advanced design variable displacement pumps. Developed to meet the requirements of the new MIL-F-19692 specification, this new series has volumetric efficiencies of 96% to 98% over a pressure range of 500 to 3000 psi . . . and has 4000 psi overload operation capabilities. These pumps have faster response and improved contamination resistance. They have practically the same envelope as constant displacement units of equal output. The first five sizes are now being integrated into advanced aircraft and missile systems; the two larger sizes are in the development stage. Write for Bulletin A-5333 for additional information.

VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

Aero Hydraulic Division - Engineering, Sales and Service Offices



Variable Displacement Pump using the Advanced Design Series cataloged in new under development.

Aviation Week and Space Technology

August 8, 1960

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August 8/15 and 15/22

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Failure Delays Mercury Launch

► Unsuccessful high angle entry experiment will be repeated, chances are for manned Redstone flight this year

Long-Rangeout Newgr Tread Crystallizing

► United-Continent proposal viewed as beginning of series, negotiating of competitive risks termed inevitable

Industry Probes Nuclear Pulse Radiation

► High intensity pulse radiation could develop weapon system control, jeopardizing success of its counter measure

SPACE TECHNOLOGY

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more news from
Amphenol R & D!

new Micro Mod micro-miniature connectors

Amphenol's aggressive research and development program in electrical interconnections has, in a short time, produced significant results. A materials "breakthrough" in resistor contacts has resulted in a line of environmentally resistant connectors that operate at 400°F continuously for 1000 hours. Advanced Micro Mod connectors with contacts on 60° centers and the Micro Mod connectors introduced in this advertisement are the first of many new product developments for micro-miniature cabling.

A central staff of engineers, physicists, chemists and metallurgists—a scientific manpower available in the connector industry—is concentrating on materials research and advanced product development, seeks to anticipate customer requirements up to five years in the future. Development staffs continue to develop special and standard connectors to current requirements.



Watch Amphenol for continued new product achievement

For micro-miniature modular circuitry, Amphenol's new 12 contact Micro Mod connectors are now available for evaluation. 360 square and weighing only 0.75 grams (0.027 oz.), Micro Mod connectors can be obtained in standard and special configurations.

Send for catalog sheets on Amphenol's new Mod and Micro Mod connectors



manufactured by



CONNECTOR DIVISION

Amphenol-Berg Electronics Corporation, General Offices, Broomfield, Alaska

EDITORIAL

Global Television Program

Within several years, millions of people around the earth will witness the first live global television via communications satellites. Recognizing the powerful political and social influence that domestic television has already demonstrated, global television may well be the most significant peaceful application of space technology for at least the next several decades.

It is not hard to visualize the impact on peoples all the way of being able to watch as they unfold the latest of the United Nations, the U.S. Congress, the British Parliament or the Supreme Soviet in action of crisis. A global television system would also enable a nation to actually show the fruits of its economic system and its culture to millions of people scattered around the globe.

If the United States acts boldly and imaginatively now, the first person to be seen and heard on television screens around the world could be an American President. Otherwise the number of countries at the world's first global television show probably will be Nikita Khrushchev.

There has been a significant lack of official comment by Soviet officials as to their plans for communications satellites, but U.S. scientists who have had private conversations with Soviet space experts agree have interest in the subject and considerable evidence of work in this area. Soviet scientists indicate that they are centering their attention on synchronous (24-hr.) satellites in a 22,000 mi. high orbit, which are particularly suited to global coverage. They also speak of new types of passive reflectors which could be more effective than the outdated balloons that the National Aeronautics and Space Administration plans to launch.

Soviet Awareness

Because the Soviets have shown such a keen awareness of the value of representing the world with Russia's technical achievements and of the impact of such accomplishments on international politics, it would be foolish for us to hope that they are overlooking these complex issues in a global television satellite system.

Within several years, the Pentagon's Project Advent may produce a communications satellite that could be used to demonstrate global television as a showcase on that item. But this satellite is being designed primarily for voice and teletype communications. First priority areas will be the military.

Recently the American Telephone and Telegraph Co. (AT&T) disclosed preliminary plans for a commercial communications satellite system capable of providing both television and voice services. AT&T estimates it could put a global system of 50 satellites into orbit and 25 ground stations into operation for about \$170 million. A more limited system using about 30 satellites to provide coverage between the U.S. Hawaii and western Europe would cost about \$10 million, AT&T estimates.

Industry Activity

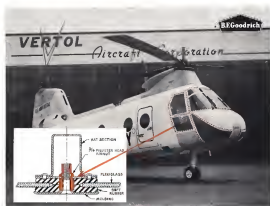
Many other companies, including the Aerospace Division of General, Space Technology Laboratories, International Telephone and Telegraph Corp., General Electric, RCA, Bendix and Space Electronics Corp., have been working on various technical approaches to a global satellite communications system.

It is apparent that the United States now possesses both the rocket boosters and electronic techniques to proceed swiftly toward the establishment of a commercial communications satellite system above and beyond the purely military requirements of the Pentagon program. It is also apparent that it will be a long time before such a system could allow sufficient return on investment to be tackled by any individual corporation as a profitable private system.

Unless more extraordinary effort is devoted to organizing a joint government industry program in this area, another tremendous opportunity to demonstrate U.S. technical capabilities will pass by default. It is becoming more and more apparent in many areas of advanced technology, such as nuclear power, supersonic transport, and space technology, that private industry cannot shoulder the whole load of developing the useful satellite system. Nor does government have the technical or managerial resources to do this job properly. We strongly recommend that NASA and the corporations with technical capabilities in this field begin immediately to consider organizing a joint effort to enable the United States to score a truly significant first in space technology and to provide the world with a new communications system of common social significance. It is an effort well worth making.

Next week we will explore some of the methods by which it might be done.

—Robert Hutz



Plastic fastened to metal— firm and weather-tight with RIVNUTS®

Large transparent plastic panels from the cockpit view down of the Vertol Aircraft Company's new YHC-1A helicopter. The plastic is firmly secured to the airframe by R.F. Goodrich Rivnuts. About 300 are installed—quickly and easily—coating in a finished seal that withstands both vibration and weather extremes.

One man fits the Rivnuts into the last section, working from one side. These Rivnuts set as blind fasteners. Attachment screws tighten the molding strips, rubber seal and plastic in a firm, weatherproof grip.

This use of blind-fastening Rivnuts insures a simple and very satisfactory method of window installation. In case other case, Rivnuts speed assembly, cut labor costs, simplify design. If you'd like recommendations on a specific fastening problem, please send a print of your part.

"UNLOCK" fastening RIVNUTS

This special RIVNUT designed for aircraft and marine fastening has 7 teeth under the Rivnut heads to lock the Rivnut to the material. Eliminates heat and layup, reinforces the hole.

For Data Book write Dept. AR-400, R.F. Goodrich Division Products, a division of The B.F. Goodrich Company, Akron, Ohio.



B.F. Goodrich Rivnuts

WHO'S WHERE

In the Front Office

C. Rhonda MacBride and W. F. Galen, directors of General Dynamics Corp., New York, N. Y. MacBride and Galen are the executive vice presidents of the corporation.

Thomas G. Ruffalo and D. G. Fabian, directors of McDonnell Aircraft Corp., St. Louis, Mo. Mr. Ruffalo is vice president security and counsel of the company, and Mr. Fabian, vice president finance.

Ray L. Ash, president of Lufkin Industries, newly formed subsidiary, Lufkin Systems, Inc., Beverly Hills, Calif.

William C. Lawrence, vice president in charge of the corporate General Development Engineering Department, American Airlines, Inc., and Frank W. Kott, assistant vice president in charge of the department's Engineering Research and Development Division.

Richard G. Mohr, vice president-engineering, Tully, Inc., New York, N. Y. **Cl. L. Boudell**, Jr., Washington (D.C.), Area Manager for General Precision, Inc. Mr. Boudell continues as executive vice president and chief executive officer of GPC Controls, Inc., a subsidiary of General Precision.

Gene Haglund, vice president controlling agent, Inc., Woodville, N. Y. **Dr. Joseph W. Wellbrock**, West Coast manager and program director for Dunbar & Sonnetry, Inc., Stamford, Conn., moved to vice president of the company.

Annie Chiswick, vice president-general sales, GFD Chemicals, Inc., Stamford, N. Y. **Viviana M. Kline**, vice president finance, Idaho Marine Industries, Inc., Chubbuck. **Richard B. Grant**, assistant to the vice president, Spire Electronics Corp., Glendale, Calif.

May Gene Harold E. Watson, Deputy Chief of Staff for Intelligence, Air Research and Development Command, Andrews AFB. **May Gene W. A. Davis**, Commander of Air National Command's Automated Systems Center, Wright-Patterson AFB. **Clayton G. Robert G. Benge**, senior Civil Servant in Division of Environment and Protection, SMC Headquarters.

Don A. Olson, sales manager of the Federal Aviation Agency's Aircraft Certification Division, Dayton, Ohio, and **Clenden W. Wells**, product manager.

Dr. Vincent E. Hunsicker, Jr., has resigned from the USAF Institute Health Division, Los Angeles, as Chief, Special Projects Division, Clinical and General Department, and has opened his office in Dallas, Tex., as professor in School of Electronic Control and Guidance, mechanical, electrical and area related engineering, testing, completion and relief work.

Honors and Elections

Col. Thurston Y. Paul has received the USAF Commendation Medal for his "meritorious service as chief of the Jupyter Project Office and as deputy commander of the Army Fillingham Missile Agency, Redstone Arsenal, Ala."

(Continued on page 119)

INDUSTRY OBSERVER

► Air Force interest in shifting from active (jetted) communication satellites to the passive reflector type because of greater operational flexibility and lower vulnerability is growing. Several recent developments may eliminate need for high-powered transmitters and large antennas now considered necessary for passive satellites. These include the reflecting cloud technique using thousands of small, long-life needles developed in Massachusetts Institute of Technology (AV Aug. 1, p. 23) and the extremely high gain array-type antennas being investigated by MIT and Ohio State University.

► National Aeronautics and Space Administration now plans to have launch capability for its Scout solid propellant launch vehicle at both Atlantic and Pacific Missile Ranges, as well as at Wallops Island, Va. Current cost estimate for Scout is \$999,000 per launch.

► Advanced solid-propellant rocket engines, called Calyps, under development at Naval Ordnance Test Station, China Lake, Calif., probably will increase little or no funding in Fiscal 1967 because it can't be projected for specific space experiments.

► Air Force-Martin Titan is scheduled for use as a boost vehicle in conjunction with the Lockheed Agos B second stage as proposed space experiment.

► Advanced Research Projects Agency-Aerco-Philco Corp., Corner 1A delivered rocket communication satellite launch now is set for Aug. 16 at the Atlantic Missile Range. Payload at approximately 475 lb. will be fired on a southeast direction for up to 100 miles over the east coast of Africa.

► NASA estimates that it should be possible to manufacture solid fuel rockets which use Nello propellant, a substance in inert weight which could increase performance as much as 25%. Solid rockets currently can be built with 90% of their weight as propellant.

► Design of a rocket engine test cell capable of testing 1.5 million lb. thrust engines, installed shortly higher than 100,000 ft. is authorized in the Fiscal 1967 construction budget for Arnold Engineering Development Center. Facility is estimated to cost \$10.5 million and take several years to build.

► NASA will spend about \$21 million of its Fiscal 1967 \$75 million lunar land, planetary exploration budget for earth vehicles. An estimated \$35 million will be spent for developing and producing space craft and payloads, with 60% of this going to industry and universities on subcontracts.

► Boeing Aircraft Corp.'s Aerospace Division has initiated design of a Mach 3 drone, using company funds.

► Materials, Inc., has been selected in Northrup Northrup Division competition to supply these adapter modules for GEM-45 automatic checkout equipment for ground laboratories as the USAF-Douglas Skybolt air-launched ballistic missile. Contractor will be slightly under \$4 million and work will be done at Materials' Phoenix, Ariz., division.

► Martin-Olinde GAM-55B, B-57, supersonic missile is scheduled to become operational with USAF in late October or November. Initial acquisition of 8-1000 fighters to be equipped with the missile is now turning over it at Nellis AFB.

► Seventh Saturn C-1 vehicle, scheduled to be launched in 1967, will be the first to have live S-IV and S-V stages and to have orbital capability. On the first three C-1 flights, Rocketdyne FH-4 engines, as the S-IV stage will be operated at 350,000 lb thrust to provide 1.3 million lb. total thrust. Next three vehicles will develop 1.5 million lb. in S-IV stage and will have a live S-V second stage.

► Boeing Aerospace Co.'s Aerospace Division is scheduled to evaluate bids this month for work at Air Force Plant 77, the MacDonnell-ICAM assembly site at HSI AFB, Utah. Work includes new buildings, rehabilitation of old buildings, roads and services.

LIBRASCOPE COMPUTER FACILITIES

Shown below is a composite view of Librascope's facilities where a variety of computer systems are currently in different stages of design and production. Some are strategically involved with national defense...others deal with business and industrial process control. Each is uniquely designed to answer a particular need. The success of these systems illustrates the value of Librascope's engineering philosophy: A decentralized organization of specialized project teams responsible for assignments from concept to delivery...and backed up by excellent research, service, and

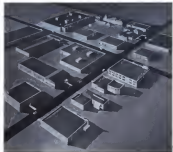
ilities. For your computer requirements, call on the company of diversification in computer technology is unsurpassed. Division, General Precision, Inc., 806 Western Avenue, Per career opportunities write to John Schmidt, Engineering



production facilities whose breadth ■ Librascope ■ Glendale, Calif. ■ Employment. ■



computers that pace man's expanding mind



Washington Roundup

Defense in Politics

Patterns of defense spending for the rest of the year will depend on how the Republicans decide to handle the defense issue during the campaign. Some increased spending is inevitable. The political problem has in looking ways of doing it without seeming to repudiate current Administration policies.

President Eisenhower left the door open for a bigger defense effort if events warrant it when he addressed the Republican convention. His closest confidants with congressional leaders could produce the decision to act for more money when he tells Congress what he expects in the way of defense and national security action during the August session.

Despite pressure from within the Republican party, the President seems determined to fight any major increase in national spending. But some programs—like Polaris, B-70, Saturn—could benefit from funding increases within the present budget. This way, the Administration could spend more money on programs in the public eye without increasing overall spending.

Democrats are waiting to see what the Administration plans to do with the extra dollars it means about before launching a new push for more money. This was evident last week in Sen. Lyndon Johnson's support for specific spending plans from Defense Secretary Thomas Gates. If the Administration refuses to spend much of it, Democrats may decide they have enough of an issue without voting one more money.

Democrats have more political worries if the President decides to spend much of the defense funds available. Johnson's program means a spend over the coming months and tend to logical excesses could possibly hurt the defense issue. The extra money then poured into the economy just before election day could hurt some of the domestic economic issues the Democrats plan to use.

New Policy on Bases

Defense Department plans a shift in negotiated contracts to fight construction delays at KCBM bases. Army Corps of Engineers will rid the wrath of the General Accounting Office by establishing a list of best-qualified contractors and asking these firms to submit bids on future bases, Titan and Minuteman base construction.

This modified negotiated contract system was similar to GAO policy, which favors sealed bids for construction jobs. Contract goes to the lowest bidder under GAO policy. The new system is designed to avoid giving contracts to "bad builders" who subcontract most of the work to other firms. Air Force and Army blame much of the delay in base construction to the confusion coming from this system.

Defense Dept. wants to keep part of the blame for base delays in a meeting late last month with top officials of missile and construction companies. Management changes are expected to ease these difficulties. Brig. Gen. Alan C. Wilfong will run all missile base construction for Corps of Engineers. He has direct access to Army Secretary Wilbur Brinkley and Chief of Staff Gen. L. L. Lemnitzer. Maj. Gen. Thomas Corbin, now AMC Ballistic Missile Center commander, is expected to replace USAF management, although he doesn't have the same direct access to the Pentagon.

Air Force and Air Research and Development Command headquarters will be briefed this week on results of Walter Study Group efforts. This group has spent approximately six months studying USAF's present electronic support system, programs and its needs in the 1957-75 period. If ARDC Commander Lt. Gen. Bernard Shriver approves, both of the Walter Study Group report will be made available to industry.

Director of Defense Research and Engineering Herbert York is not expected to authorize program for development of low-altitude vehicles. Critics view it that such a program often interferes little to match expense of such a program. York's staff also doubts the Soviets will find low-altitude satellites sufficiently attractive, but has asked Air Force to launch a program to develop the more numerous birds requires reported for satellite interception in case current approval of Secret intentions proves incorrect.

Space Symposium

Air Force Office of Scientific Research is announcing its series of symposiums commencing with a meeting in October. Third symposium on the same will be held with the Society of Automotive Engineers in Los Angeles Oct. 12-14. Last meeting was held in Denver in April, 1959.

Series is continuing after a 21 year hiatus caused by national space politics. A meeting was scheduled for May, 1938, but it was canceled officially because of a conflict with the World Congress of Flight. The cancellation came at a time when National Aeronautics and Space Administration was striving for the lead role in the national space effort and when Pentagon policy and discussion were in various attempts to develop permanent individual space roles.

—Washington Staff

Failure Delays Mercury Launch Goals

By Edward H. Kalkreuth

Washington—National Aeronautics and Space Administration has revised the Project Mercury test schedule to replace the initial high-angle recovery test, an experiment which failed completely July 28, draining almost of a second Atlas boost ballistic flight before the end of the test.

U.S. manned satellite program suffered its most significant setback when an Atlas launch vehicle exploded 65 sec after ignition. The MA-1 booster was carrying a McDonnell Aircraft Corp. capsule on a mission to qualify the capsule in a severe test of structural strength. About 36 hr after launch, chase crew recovered pieces of the contaminated capsule shell. Although onboard telemetry tapes were recovered intact, NASA said not one basic flight objective was achieved.

Atlas failure casts doubt on a reasonable goal of a manned Redstone ballistic flight before the end of this year, also. NASA will now attempt manned capsule flights until the capsule structure with integrated systems is fully flight tested.

Great concern exists because the compressed Mercury schedule calls for consecutive Atlas and Redstone flights to take place this year, however, a better flight schedule with no serious system failures must be completed during the next few months.

Immediate results of the MA-1 failure was commitment by NASA of the second Atlas launch (MA-2) in a repeat of the high-angle recovery test. The agency had hoped to obtain full data on high velocity recovery in three Atlas ballistic flights. Instead test objectives require continuation of the capsule recovery in a recovery of about 10 day. This will be followed by either a normal recovery (two degrees) or an escalation of an abnormal situation immediately after recovery into orbit.

NASA said now double the test program by engaging a backup Atlas and a backup McDonnell capsule to repeat MA-1. The agency has not assigned specific missions to all Atlas launches in 15 Atlas and eight Redstone boosters.

Flight development program will continue with contaminated capsules, followed by clean capsules, post a successful flight.

Uncontaminated MA-1 had a programmed mission profile of 2,300 mi. stage, 110 sec. apogee and 10 min. flight time. Capsule was to have been subjected to extreme tests of strength and structure as effectively testing such as would oc-



PRODUCTION shell of the National Aeronautics and Space Administration McDonnell Project Mercury space capsule is lifted to be mated to Atlas launch vehicle. Capsule must meet 200 lb. of instruments and a 20 in. shell stress exceeding pilot escape system.

cur following an abort during powered flight.

Rena and glass fiber heat shield would have reached a temperature of 3,000°F, and the aluminum, through fire exposure, would have experienced an actual temperature of 1,500°F. Structures would have been further tested by 25 g and when the auto-dump capsule entered the atmosphere at a velocity of 11,300 mph.

Profile was to have been altered by shutting down the Atlas launch engine promissory about four minutes after ignition.

Actual flight, conducted in diving arc, took the capsule to a range of five miles and an apogee of six to eight miles. Telemetry was received from the booster for 65 sec. and from the cap-

sule about 14 min. Capsule apparently was in the air for 14 min., once it burst on impact and did not fall. Windage was found to be 50 ft. of water. Salvage efforts are continuing in hopes of finding enough of the launch vehicle to determine the malfunction.

Capsule was fitted with a 20 in. steel brace instead of the 16 ft. pilot escape pylon. This was to have been attached to simulate pylon separation in the flight sequence.

Atlas booster in the MA-1 launch was equipped with an abort-ignition system on an open loop instead of timing devices to the telemetry.

George M. Low, chief of NASA's manned space flight program, said the pylon tower test occurred because it was not been flight tested with the short

circuit on a closed loop. A collection of the closed loop short system could have triggered the escape cycle and prevented an orbital response of data on primary test objectives.

Installation of the escape tower would have cost approximately two weeks delay. For additional checkout plus installation of a more complex flight sequence, he said. Flight or sequence need was proposed to retrofit three months after launch.

Normally, short system will receive engine performance, attitude, integrity, velocity and vehicle motion. Malfunction will cause automatic ignition of the escape rocket as time loss before ignition in separation from the launch pad Atlas booster.

Telemetry received during the flight confirmed by recovered tapes in the capsule, show short system required pre before powered flight terminated loss, and Tape will be of some value since it shows capsule behavior in error state. Q) Instrument channels (person) recovery and will provide test data for the first test on a McDonnell capsule. MA-1 test capsule was down with little fuel because Jan. 31 (AW Feb. 1, p. 12) to qualify pilot escape system under maximum dynamic loads.

Low did not minimize the MA-1 setback with its loss of time, money and a backup system. A technical assessment of the failure in delay of the overall program cannot come until MA-2 is flown, he said.

Little time will be lost if the structure proven to be sound during the next launch. If the report shows structure deficiencies, the minimum loss will be the time between the data plus the time necessary to rectify the deficiencies, Low said.

If MA-2 does not result in a good launch, flight and recovery, remarkably MA-3 would be another high-angle recovery test.

NASA has ordered an expedited number of launch capsules, bringing to 24 the production order with McDonnell Aircraft Corp. MA-1 capsule was constructed by NASA's Langley research center, but construction of remaining capsules will be done at the McDonnell plant in St. Louis, Mo.

Because instrumentation is record data from all Atlas ballistic tests is now in, no delay will result solely from changing the mission of MA-2 to a high-angle recovery flight.

Instrumentation consists of a 16 channel telemetry system, two type or sensors, two 36 mm. cameras, heat sensors at 51 points, plus sensors for pitch, yaw and roll rates, accelerations, pressure, vibration, external noise levels and flight footcandle, including action of adaptive band reflector, capsule separation and escape chute deployment.



ARMORIED Mercury-Ath 15 ft. high with a thrust weight of 250,000 lb. Test failed when launch vehicle exploded 65 sec after ignition. Objective was to test structure to severe high angle recovery. Experiment will be repeated in next Atlas-boosted launch.

Life Sciences Coordination Urged

Washington—Opportunities to duplicate use of the nation's space facilities in other and the effort to direct cooperation in this field between the National Aeronautics and Space Administration and the Department of Defense was expressed last week by the Senate Committee on Aeronautics and Space Sciences headed by Sen. Lyndon Johnson (D-Tex.).

The report expressed doubt that NASA's Office of Life Science Program has a well conceived plan for future coordination, stating that the Cordell-Hillary-Larson Committee which met 11 times between October, 1958 and December, 1959, failed to achieve general coordination between NASA and Defense.

On the pending level, the Senate group noted that there is close and continuing cooperation between civilian and military agencies in the field of space biology and medical sciences to meet the free distribution and broad outlook of the individuals involved.

Many of the life scientists were the government as a variety of advisory boards and committees. The report pointed out that these groups meet infrequently, however, and they lack close-knit participation in the operating decisions of the organizations they advise.

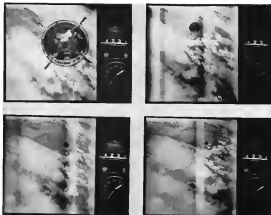
The report questioned whether, as the NASA effort increases and the very serious substantial proportion of the life scientists personnel and facilities to NASA without adequate coordination, the program could justify future budget requests on the basis of work performed for NASA.

NASA told the committee it would coordinate Defense Department for purposes aimed at in military biomedical locations which are specifically for NASA projects.

The report said... there is a need for revision of a policy statement in suitable act of guidelines by life science organizations showing how they may conduct business on a permanent basis."

NASA Office of Life Sciences, established May 1, 1960, will have a staff of 12 professional and supporting personnel by Fiscal 1961 and a total program expenditure of \$5 million. Future personnel staff will be 60 and existing supporting personnel.

Dr. S. I. Gershenfeld, in report on cooperation in space flight and biomedicine with the Ames Research Institute Agency, recently joined the space agency life sciences staff in short appointment. Dr. Richard S. Young, also formerly with ARPA, will be chief of flight biology.



Redstone Tests Missile TV System

First pictures of new Avco vidicon system shown last Redstone tracked in terminal phase of its ballistic flight. Radio Corporation of America instrument package contains three video cameras with narrow angle lens oriented perpendicularly at an altitude of about 40 miles. High-speed video package delivers steady beam, transmitting high resolution pictures to ground stations. Instrument capsule in several video tubes worked at impact, which Avco says permits maximum assessment of missile performance and design. Ground station has direct view cameras, two cameras, video tape recorder and 15 mm. photo camera. This instrument, video view a 15mm. vidicon, is video tape equivalent of a Redstone war zone traveling at Mach 4 to target on the White Sands Missile Range.

Defense Pressed for Budget Plans

Washington—Senators majority leader Lyndon Johnson (D-Tex.) put pressure on Defense Department last week, to release \$1.2 billion in unexpended funds for key programs added by Congress in the Administration's Fiscal 1961 defense budget.

Sen. Johnson, the Democratic vice presidential nominee, also challenged Defense Secretary Thomas S. Gates, Jr., to say whether any new funds voted for defense in the August session of Congress would be spent.

The Administration has already released some of the funds for construction of five new fast ballistic missile submarines. The Administration budget fully financed three submarines, and Congress added money for two more.

In a letter to Gates, Sen. Johnson said he expects to discuss the

Senate. Preparedness Subcommittee noted that Congress made additions to the Fiscal 1961 budget "after careful consideration." It requested that Gates furnish the subcommittee "with a clear-cut statement concerning current Department of Defense policy with regard to cancellation and full utilization of the additional funds provided by Congress. This statement should cover such of the individual items or programs for which Congress provided funds in excess of the budget request."

Other information requested by Sen. Johnson.

"The specific steps that have been taken, as well as those planned to be taken, in order to eliminate waste in contracting, supply management, and other procurement activities in order to relieve the common call

for by the Congress in procuring funds.

"A complete accounting of the opportunities known today to date with respect to funds available for FY 1961."

"The specific 'shopping list' submitted for approval by the military departments, as well as changes made by the Office of the Secretary of Defense and the Bureau of the Budget and the results in such changes."

"Whether a June 9 memorandum issued by Gates to the three services 'has more been repudiated or recommended.' According to Sen. Johnson, it read: 'If the Congress makes available more funds for FY 1961 than are requested, and where the law does not require expenditures, agencies should reserve the monies and carry them forward to the maximum practical extent to FY 1962.'"

Avro Continuing VTOL Wind Tunnel Tests

Washington—Continued U. S. Air Force and Avco support of the Avro VTOL research aircraft began its wind tunnel tests one order up at National Aeronautics and Space Administration's Ames Research Center.

Delta-shaped VTOL research aircraft built for the U. S. Army and Air Force by Avco Aircraft, Ltd., of Canada (AW Dec. 7, 1959, p. 1316), has been tested extensively in the full scale 40 x 80 ft wind tunnel at Ames. Those wind tunnel investigations have been in progress for several months, and the current test results have been favorable enough to warrant a continuation of the program after modifications to the aircraft.

Stability of the vehicle at low speeds both in and out of ground effect has been a major problem. Flight tests of the vehicle outside of ground effect have not been scheduled.

Vertical Takeoff

Aircraft is designed to move rapidly along the ground and achieve a vertical takeoff by operating in a strong cushion of air when it is within one wing diameter of the ground. The mechanism is limited by discharging an upward jet of air downward from the top of the circular wing. Pressure is from this en-

velope jet is pushed by the large fan located in the center of the vehicle.

This pressure flow is augmented as it is exhausted around the circumference of the wing by passing it through a nozzle which creates a jet pump effect and draws in a large volume of relatively low speed air. Large opening at the edge of the wing is the inlet for the augmentation air flow. A boundary layer bleed for air drawn into the vehicle is jet inside the secondary air inlet.

Fan for the primary air is driven by a gas turbine and is similar to the GE-6 fan described below. Three Cincinnati J91 turbopumps produce the hot air to power the fan.

Horizontal flight for level flight is possible by deflecting the primary jet of air to the rearward. The aircraft can now not be turned through a 90 deg. angle, so that it always contributes to the total thrust lift. Several versions are being tested to find the most efficient means of turning the jet to achieve horizontal flight. Aircraft stability depends upon keeping the flow smooth as it turns around.

Configurations shown in these photographs has wing edges and air inlet for the augmentation flow which are designed for subsonic flight. Supersonic

version of this more general test vehicle has been considered which has sharp wing edges and a modified inlet system for supersonic augmentation flow.

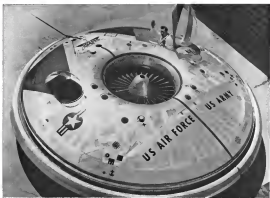
Circular wing planform has potential for subsonic aircraft because it is structurally compact and light and because it is an ideal shape for very high speed flight at low altitudes if its stability problems can be corrected. Studies by NASA, Avco and several other aircraft companies have indicated that the most efficient aircraft for high speed use level at transonic and supersonic speeds probably will be wingless. It will require very low lift coefficients and will not benefit from a long, narrow, high aspect ratio wing. Reduction of control area is a primary design consideration for low wing with a low level aircraft, and the circular aircraft is ideal on this point.

Circular Aircraft

Circular aircraft will be relatively inefficient below 500 mph, however, because its aspect ratio is only 1.35 and its drag due to lift will be very high.

Current test work has not been completed, but it has shown that the stability and maneuverability problems with the circular aircraft are not unmanageable.

HIGHLY SLEAVED wing edges characterize subsonic configuration of the Avro delta-shaped aircraft vehicle for USAF, Army.





ORBITAL BOMBER cockpit markup, designed by Lane for USAF, is first attempt at control and display system for space weapons system. Flight group instruments for heading and velocity, attitude left and right, air speeds in front of pilot and copilot. Center display provides instruments for orbital flight and control of five ballistic weapons. Head group are used to determine vehicle maneuvers.

USAF Shows Orbital Bomber Cockpit

By Philip J. Kline

Grand Rapids, Mich.—Cockpit control and display system markup for a four-axis orbital bomber, designed to cruise at a 100 mi. high orbit for up to 30 days, is being demonstrated here to representatives of the aerospace industry and will be shown to DOD-S&T project personnel early in September.

The orbital weapon system cockpit, developed by Lane under Wright Air Development Division sponsorship for a hypothetical vehicle, represents the first detailed analysis of the display and controls required for an orbital bomber.

Equally significant is the approach, or methodology, which the WADD-1-10 program has developed for the design of aerospace vehicle cockpits, based on a detailed, step-by-step analysis of each operation required of crew members throughout the mission. This methodology is equally applicable to all types of aerospace vehicles.

The orbital bomber control and display system, identified as the Mark IV, is largely a static markup. Instruments

are positioned, prototyped, but some indicating lights and a personal display are non-operational.

During the critical no-entry phase, the pilot as copilot can select an energy-downing display for entry viewing which shows predicted heading position of the vehicle relative to its desired base vehicle's multibody temperature, angle of attack, bank angle, position and distance, to go.

At the top of the center display, an orbital group, which can be viewed jointly by the pilot and copilot, are to select digital information which shows velocity, attitude, velocity, orbit inclination and power and ascending node.

Display Area

The four main orbital header selected by WADD as the primary vehicle for the Mark IV has a crew of two pilots and two technicians. The virtual display area is divided into three nearly equal sub-areas. Two of these, one each in front of the pilot and the pilot, contain the basic flight instruments as viewed during launch, entry and landing. The pilot and copilot displays are identical. The third sub-area between the other two is devoted to instruments which display orbital (positional) conditions, vehicle measurement and controls for weapon management.

The flight group displays, directly in front of the pilot and copilot, contain several familiar instruments, such as a dual-dimensional moving globe which indicates vehicle attitude and heading relative to earth coordinates and vertical moving-type indicators for altitude, airspeed and angle-of-attack.

New Instruments

New instruments, required because of the vehicle's orbital nature, include:

- **Rate indicators**, which display rate of rotation of vehicle about each of its axes. Simultaneous rate indicators that indicate change of attitude display is required in point because pilot to stabilize vehicle with appropriate compensation of attitude of fuel. Rate indicator is positioned directly above moving globe attitude display.
- **Temperature indicators**, showing both real and time temperature during re-entry consists of moving-type true vertical display contained alongside of indicator showing engine-outlet and flight path angle. Additionally, there are readily indicators to show temperature of body, nose and each wing during re-entry.
- **Viewing screens**, directly in front of the pilot and copilot and under the flight group, can be used to display a view of things, ranging from checklists to navigational maps. Because the cockpit has no windows, the display screen can be also used for external viewing, using optical telescopes or closed-circuit television. Particular display shown as the screen can be selected

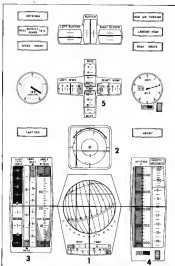
individually by pilot and copilot, displaying again their operational needs of the moment.

During the critical no-entry phase, the pilot as copilot can select an energy-downing display for entry viewing which shows predicted heading position of the vehicle relative to its desired base vehicle's multibody temperature, angle of attack, bank angle, position and distance, to go.

At the top of the center display, an orbital group, which can be viewed jointly by the pilot and copilot, are to select digital information which shows velocity, attitude, velocity, orbit inclination and power and ascending node.

to the right of these general-position and are often the effect which display computer-produced information, such as time to go to re-entry, or to burst altitude.

Below the orbital parameter display are limited instruments for viewing the vehicle and other environment. A rotation display shows the amount of rotation change accelerated since the mission began as well as a warning light to show if high severity position is being encountered. Other instruments show the remaining supply of nitrogen and oxygen for crew supply as well as rocket engine fuel remaining. The displayed information and



MARK IV for orbital bomber shows three-dimensional light-type attitude indicator (1), three-axis rate indicator (2), moving-type indicators for flight path angle, body and nose temperature and engine-outlet (3), viewing-type indicators for altitude and airspeed (4), and readily indicators for body, nose and wing temperatures (5).

Hydraulic power system performance

The wingman control and display panel is located in the subfuselage approximately at the same level as the viewing screen in the flight group and contains a provision for setting in target coordinates for five infrared missiles as well as lights to indicate weapon readiness.

Accordingly, below this section is the control and display panel for vehicle communications. Located on a console situated midway between pilot and co-pilot seats are interferences switches and circuit breakers.

Primary controls for automating the vehicle are handling and guidance tabs to support the pilot's and copilot's cross. Grips are created so that grips are angled downward, upward and toward the pilot. The right-hand grip is used for all three axes, with primary grip control by the application of force about the appropriate axis without actually rotating or moving the grip. Left-hand grip provides switches for critical vehicle controls.

In designing the Mark IV cockpit control and display system for an orbital bomber, Lear's Advanced Engineering Division was able to work within the small constraints imposed by designers of conventional airplane cockpits who cannot depend too heavily from long, wide cockpit configurations and instrument arrays, according to Edward Werner, WADD's project engineer for the Mark IV program.

Time Line Analysis

The "time line analysis" concept used by Lear's Advanced Engineering Division in the Mark IV was developed originally in WADD's Flight Control Laboratory. The current analysis represents an early stage application.

Thanks to the time line analysis methodology, both the vehicle configuration and its mission are analyzed in detail before any attempt is made to design the required instrumentation. A detailed flight profile is then brought through effort to identify in a preliminary, listing every task that must be performed during the mission. These are then analyzed on a time scale to determine which should be assigned to each crew member or whether they should be performed automatically, according to Edward King, associate manager of Lear's Advanced Engineering Division. King formerly was employed by General and worked on B-70 cockpit instrumentation.

Each task is then analyzed to determine what information the assigned crew member requires to perform the function and how such information can best be displayed. In some instances, information is categorized to eliminate redundant or different display and/or control configurations.

Polaris Test Vehicle Destroyed After Flying Off Planned Course

Washington—Erstwhile flight following a normal launch resulted in destruction by a range safety officer last week of the fourth submarine-launched Navy-Lockheed Polaris test vehicle.

In three earlier tests, things from the nuclear submarine USS George Washington, Polaris test vehicles flew 1,000 miles and Navy and test crew all test objectives.

Fourth test began with a good routine from the launch tube and progressed smoothly. After 25 sec of flight, the vehicle sped to the left of its planned path. It continued south but immediately appeared to lose control about 40 sec after launch. It was destroyed 47 sec after launch.

Following the shot, the George Washington left the Atlantic Missile Range for its home port at Charleston, S. C. Later in the week the Navy fired a Polaris test vehicle from the Ships Mission Simulator and planned to fire another from the fleet yard. The vehicle launched from SSMS carried a warhead trigger on the first flight test of the Polaris nuclear warhead system and having succeeded. The second test, Polaris missile submarine, 158th Patrol Flotilla, will arrive at Port Canaveral later this month for a series of Polaris test vehicle launches and shipboard system checkout.

Meanwhile, the Navy has established the framework for further development of its Polaris system during a period when the system has become the subject of diplomatic discussion.

Under present plans, Lockheed will produce three tactical versions of the solid-fuel missile, the first of which will be used only on the George Washington. Patrick H. Jones, Executive Vice-President, Robert E. Lee and Abilene, Texas, said the A-1, the initial Polaris will have a range of 1,300 mi and will be identical to the first test vehicle fired by the George Washington, with instrumentation removed.

The 1,500-psi A-2 will be 30 in longer than the 25-ft A-1. All FBM submarines under construction or planned in the remainder of the 45-month program will be built with longer tubes for the A-1. In addition, the test submarines in construction or outfitting will be substituted with longer tubes when they return to upgrades for periodic overhaul.

Fifth test, for FBM submarines in the George Washington class and five in the second submarine Ethan Allen class. Ethan Allen class ships displace 6,600 tons and are 410 ft long. Third generation will be the future class, four of which Congress planned in the Fiscal 1965 budget (AW Feb 25, p. 35). They will displace 7,000 tons, and the Navy says they will be the lowest value-submarine ever built.

The 2,500-psi A-3 will have the same external configuration as the A-2. Range increase will come from higher cruise, fuel and lighter weight warhead and improved motors.

The question of general acceptance of Polaris by North Atlantic Treaty Organization nations remains unsettled (AW Aug. 3, p. 27). French President Charles de Gaulle apparently is seeking a more attractive formula than dual U.S.-French control of nuclear-armed Polaris missiles before committing his country either to acceptance of Polaris or rejection in favor of French development of a medium-range missile.

In Britain, the Polaris situation has developed into two separate considerations. One is the latest spectrum of NATO and members of the Atlantic Pact land-based institutions. The other involves negotiations on British participation.

The British desire that U.S. use of British ports for submarine resupplying be subject to a general re-examination of U.S. use of British bases. Negotiations are under way concerning a separate agreement for use of British ports by U.S. submarines.


Thornycroft Succeeds Sandys

No change in the government support policy for the British aviation industry is expected as a result of the ministerial changes announced last week, despite the fact that Peter Thornycroft, who succeeds Duncan Sandys as minister of aviation, stepped from the post almost two years ago because of his contention that the government was over-representing public funds.

The industry believes that Thornycroft will accept both qualitatively and quantitatively the commitments assumed by Sandys, but is leery of further financial and contractual arrangements.

It is believed that the new minister may even relax the prospects of industry looking for the expensive services and a price program. Industry was leery in the first of both projects, but failed to push them through as recommended then.

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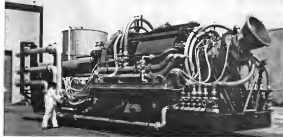


THE MULTI-TURBINE POWERED, TANDEM-ROTOR VERTOL 107

was designed around the specific requirements of the Army, Navy and Air Force—the first truly all mission, all service helicopter ever built.

The VERTOL 107 prototype recently demonstrated its all-service compatibility to European military leaders during a 16-week tour. The all-weather 107, with its strength in near loading ramp, quickly loaded cargo of many different types and sizes—made numerous water landings and take-offs—proved its easy handling, high performance, and stability to pilots of all three services and to commercial operators.

Today's most advanced turbine-powered helicopter—the VERTOL 107 Model II—is ushering in a new era of air mobility for today's military and commercial operators—offers mobility and performance unequalled by any other helicopter.



Tory IIA Reactor Scheduled for November Test

Tory IIA experimental reactor, the first to be tested in the Air Force Propul-Pulse nuclear-propulsion program (AV, June 26, p. 206), is scheduled to be tested in November at the Atomic Energy Commission's Nevada test site. Exhaust gases for its power through the reactor is ejected up 14 ft. at right. Air will flow through the reactor at about 1,800 ft./sec. and at pressure up to those encountered during Mach 5 flight at sea level. Tory IIA is rated at 140 megawatts, and the follow-on facility, part of the Tory IBC reactor will be 400 megawatts. Tory IIA is in the design stage and is scheduled for test in the summer of 1962. It will have many characteristics of a flight-weight reactor, with provisions made for conserving and accelerating heat.

Defense Department Revises Security Rules

Washington—Defense Department has revised standards and procedures for clearing contractors and their employees to handle classified material.

New regulations cover more than one million defense contractor employees, and for the first time, coverage will extend to National Aeronautics and Space Administration and Federal Aviation Agency, which will have their classified contracts handled under the Armed Forces Industrial Security Regulations.

Changes stem from a September Court decision which held that the Defense Department lacked authority to withhold classified information from contractors and their employees in certain cases because the procedures used had not been authorized by the President or Congress. A presidential executive order was issued requiring detailed regulations.

New rules require that all information and evidence must be submitted to a Field Board in the applicant's presence, and the applicant will have a chance to cross-examine witnesses and examine documents.

Field Board makes a recommendation, but the final decision rests with a Central Board, which has power to hear written appeals and arguments and to refer cases to the Defense Secretary or the National Aeronautics and Space Administration or FAA administrative

Lookheed Aircraft Corp. passed its third quarter dividend last week. First full results and details of the Tiberco and Hughes financing will be revealed this week, when Chairman Robert E. Goetz appears before the New York Senate of Security Analysts. Lookheed, which has been paying a \$1.25 annual cash dividend, paid its second quarter dividend in stock to current shareholders.

Catback in production of Hercules-Pag. Victor Mark II bomber was made last week by Bell Aircraft. Also, analysis of the V-1000 engine, a derivative of the Douglas X-15 engine, is under way. Analysts reported 12.25 hours, which cost \$3 million each. Catback may have been used by Lockheed in the production of the X-15 and because Viper's, some knowledge of the test has not been established.

Mr. Gen. John B. Medaris, former chief of the Army's research program, has been elected president and a director of the Loral Corp., formerly the leading manufacturer of model tanks and accessories. Loral recently expanded its activities in developing new electronic applications based on a 15-year research program.

X-15 set an unofficial new speed record at 3,113 mph (3,113 mph) at 60,000 ft. last week, preliminary flight record analysis indicated. Aircraft was

News Digest

X-15 No. 1, fitted with interim XLR-11 engine, X-15 No. 1, 1,115 (1,094 mph) in Sept. 22, 1959.

Lookheed Aircraft Corp. and Martin Co. have been awarded \$100,000 in research contracts by the National Aeronautics and Space Administration to study nuclear rocket engine concepts for Project Rover.

Post & Whitner H-12 helicopter engine, now being in Lookheed Jetstar and the North American X-15, are now being developed by the National Aeronautics Agency at 1,000 ft. and 1,000 ft. total weight, after a 10-month development period.

Federal Aviation Agency ordered an emergency inspection last week of all Sikorski H-12 main rotor blades following the crash of a Chicago helicopter. Sikorski H-12C. Under inspection that all main rotor blades with 1,450 ft. of service time be withdrawn from service, and that all blades with 1,800 ft. be X-15 inspected date.

Defense Department and National Aeronautics and Space Administration will award Mr. Robert H. Goddard and the Goddard Foundation \$1 million in settlement of a patent claim covering rights to more than 200 of the late Dr. Goddard's inventions on rocket and space research fields.

AIR TRANSPORT

Long-Forecast Merger Trend Crystallizes

United-Capital plan viewed as beginning of series; regrouping of competitive routes termed inevitable.

L. L. Doty

Washington—Proposed merger of Capital Airlines into United Air Lines (AW Aug. 1, p. 14) is being viewed generally by the airline industry as the first step in an inevitable regrouping of competitive routes.

Initial reaction to the proposed alliance suggests that opposition by certain operators, at least south of the belt, but that within strong the already-glittered Florida market (AW Jan. 18, p. 36) can be expected to pass the plan. In most east-west markets, competition generally would be reduced by the merger, but the introduction of well-equipped United with its strong resources into Florida will serve to intensify the current hot race for traffic in that area.

Nevertheless, most top officials feel there is no alternative to Capital's final flight, which has led the airline to the brink of bankruptcy (AW Aug. 27, p. 36). Others feel the consolidation will merit the approval of the Civil Aeronautics Board as well as good. Although Capital stockholders and bondholders will suffer an initial loss, potential gains are greater through the merger south than they might have been had the carrier been forced into receivership. Thus, they are expected to support the plan.

The two realities of merger as a means of sharing routes, controlling excess capacity and ending competition has been acknowledged by industry leaders for some months (AW Dec. 18, p. 36). W. A. Patterson, United's president, in what now proves to be a prophetic statement, told American Wings earlier this year that the trend for mergers will be left as "such as next September" (AW Feb. 26, p. 42).

More Mergers

If it is accepted, the United-Capital consolidation, coupled with the proposed Northeast-TWA merger (AW May 28, p. 58), will end the number of traditional four-airline routes of 11 to 16, and add a few airline officials feel that the total will drop even farther as more current air routes are merged through economic necessity.

Not much will be a complete reshuffling of present routes which will tighten competition to a degree that will permit the operation of high-capacity jets on all efficient routes within time. In the process of consolidating a number of regional-type routes will be pared off to lead active carriers to provide that group with new strength.

If the United-Capital merger is realized, United will be substantially strengthened by gaining an entry into the Florida market and by taking its noncontested routes with virtually every major city on the Atlantic coast market. At the same time, competition in Eastern markets presently served by both carriers will be cut.

Number of carriers in the Washington-Chicago market will drop from four to three. There will be four carriers instead of the present five in the New York-Chicago and New York-Detroit markets. The market will be reduced from three to two in the Philadelphia-Chicago route, a market that has grown in importance in recent years.

At the same time, assuming that the

CAL will not acquire new operating subsidiaries in the merged system, United will represent the Chicago-Tulaho-Washington and Chicago-Columbus-Detroit-Washington routes with the highly profitable Chicago-Detroit-Cleveland-Pittsburgh-Washington route now operated by Capital. It will gain access to Minneapolis-St. Paul with mounting rights from the two cities to eastern markets.

United will win winning rights between Milwaukee and New York and will inherit the important Chicago-Detroit-Buffalo-New York route. It will also absorb the local-to-local Washington-Vienna route from Capital's charter.

New Competition

None of these route realignments creates new competition for any carrier already serving eastern markets. United, however, will offer American Airlines new competitors on the route between Buffalo and Rochester, N. Y., and the West Coast. And because of Capital's strong position in the Pittsburgh market, it will bring about a new competitive impact against TWA in the Pittsburgh-War Coast service which United has not so far fully used.

United will assume a substantial volume of new traffic volume when it takes over Capital's franchises to operate between Cleveland, Pittsburgh, Buffalo and Miami and between New York, Pittsburgh and Atlanta and New Orleans. The merged airline can be expected to lead the reformation of eight major points in transfer of a number of routes to new service carriers (AW July 4, p. 44).

Beyond this, effect the TWA-Northeast and United-Capital merger will have competitive effect on routes that will be significantly weakened at least temporarily. Since the basic purpose to local air merger is to coordinate economic strength while creating operating units, such conditions within the industry must be expected.

Patterson and at the time, the proposed merger was announced that no plans had been developed for the absorption of the more than 7,000 people now employed by Capital. However, there can be no doubt that there will be fewer positions available in the merged airline than there are presently within the two separate companies. As a result, some unemployment within the airline industry can be an inevitable outcome of the merger.



CAPITAL AIRLINES routes (black) superimposed on a United Air Lines route map indicates deployment pattern of the two airlines and new routes United would gain. The latter includes Cleveland, Pittsburgh and Buffalo to Florida routes, and New York to New Orleans and New York-Atlanta service. Capital also serves numerous intermediate points in the south. United also gains a Chicago to Minneapolis route. Principal Capital/United deployment is on Chicago-New York and New York-Washington service.

At the same time, vendors, suppliers, carriers and manufacturers will temporarily feel the pinch of cutbacks in the volume of purchases of goods and services. As one airline official put it: "A general regrouping of the industry is shaping up that will be a definite setback on suppliers' business until such time as the overall adjustment works itself out. From that time on the industry will start a new period of growth as it expands from its new base."

Stockholder reaction to the proposed merger is not illustrated by the activity of Capital's common stock listings on the New York Stock Exchange. Following the official announcement of the merger, Capital stock plummeted 12 points in a single day, and continued to slide for the year end 1961. United stock held its own and had settled in its recent average of 30-31 as of late last week. Capital's stock has reached a 1956 high of 77 1/2, a low of 24 1/2.

Under the proposed plan, Capital stockholders will receive for each share seven shares of common stock they hold one share of United common stock plus a five-year warrant to purchase 15 shares of United at \$40 per share. Annual ac-

quirements of the two companies as of Dec. 31, 1959, showed United with 1,946,000 shares outstanding and Capital with 909,619 shares outstanding.

On this basis of the exchange, Capital stock is valued at approximately \$4.15 a share.

A simple majority of United's shares is needed for approval of the merger. A two-thirds vote of Capital's common shares and two-thirds of the legal liability' vote must be obtained before the merger can be approved.

Victory-Amerasia, British subsidiaries of the Victory-Amerasia Transport, has approved the proposed merger. The company has filed a declaration of intent against Capital for full use of its \$18.5 million in the notes covering the Victory-Amerasia.

Merger Approval

In addition to the stockholders of both airlines and Capital bondholders, Civil Aeronautics Board and Securities and Exchange Commission must approve the merger before it can be consummated.

The merger undertaking will cost United about \$12.5 million, including the costs of the warrants, according to Patterson. United will raise the Victory-Amerasia \$11.9 million at a 5.5%

cumulative preferred stock, 60,000 shares of common stock, 73-year warrants to buy 200,000 shares of United common stock at \$45 per share and 15 percent preferred stock not subject to the provisions of the merged companies.

The merger agreement also calls for the offer of 30 shares of common stock for each 51,000 preferred shares of Capital's 4 1/2% convertible subordinated debentures.

In the merger, which may be finally approved as early as February, Capital will be completely absorbed by United and lose its identity entirely. The airline will continue with corporate assets of United Air Lines, and Capital's headquarters facilities here will be closed.

The merger was suggested largely by Thomson D. Norland, who was named chairman of the Capital board last spring (AW June 6, p. 61). Norland was brought in to the position because of working Capital out of its financial dilemma.

Capital is the product of a merger of Pennsylvania Airlines with Central Airlines in 1936 in Pennsylvania Central Airlines. The corporate name was changed to Capital in 1948.

FAA Negotiates Sharp Reduction In Military Airspace Restriction

Washington—Federal Aviation Agency has brought about a sharp reduction in the prohibited airspace around the Los Alamos, N. M., nuclear installation in the latest phase of 46 days to open military airspace open to public traffic.

The action brings on a total 12,026 sq mi the areas that have been removed from the military services from restricted classification in the past 34 months since FAA first launched its program to eliminate all restricted and prohibited airspace that could not be justified. As a result of the program, there are now only seven U.S. aircraft flies which still aircraft are based.

The Los Alamos airport, from which civil aircraft are prohibited from operations, has been reduced from 346 sq mi to 43 sq mi. In another sector, the entire 771 sq mi prohibited area at Oak Ridge, Tenn., was revoked and is now open to civil traffic.

For a number of years, legal sections of airspace blocked off by military services as restricted or prohibited areas have been the target of much public criticism. The current move dispels that much of the military airspace was unnecessary and forced aircraft to undesirable costly detours from established routes in order to avoid the prohibited areas.

Prohibited areas are normally identified by presidential order and units of civil aircraft from entering the area for reasons of security. Restricted areas are closed off to civil aircraft and aircraft operations or primary purposes.

Responsibility for the clearing of airspace was granted to FAA on May 15, 1959. In July of that year, FAA issued a special regulation outlining the detailed information report by the controlling agency of each restricted area. A large volume of material was submitted to the FAA following requests of the regulation. In addition, surveys and consultations with the controlling agencies of the airspace under question resulted in further restrictions.

In some areas, public restriction has been reduced permitting public use of the airspace on a go-ahead or seasonal basis. In some areas, this point was dropped was abandoned.

At the same time, FAA has established revised additional restricted areas in order to meet military requirements. For example, during last and July military closed airspace, about 69 sq mi in size, has been opened at Miami, N. D., Elkhart, Pa., Ore., Concord, Me., Mt. Greer, Mich., Limestone, Me., and Vancouver, B.C.

As of July 31, FAA has revoked 36

restricted areas and two prohibited areas. Total of 26 new restricted areas have been established 12 restricted areas, six restricted in use and four restricted in use. These designations of 12 restricted areas totaling 2,499 sq mi have been reduced, and 12,026 sq mi have been reduced, and 12,026 sq mi have been reduced.

There are a number of the reasons listed by FAA during the past two months:

- **In the southern portion of the large eastern California complex**, a major source of controversy between the military and civilian aircraft operations, a 113 sq mi section was released. In the same general area, a 30 sq mi restriction was reduced to a restricted portion of the Buffalo Mountains mountain area. The restriction was accelerated the move-

ment of traffic between the Los Angeles Long Beach area and from Los Angeles to points east.

- **Restricted military aircraft corridor** was reduced in Washington, W.V., reducing 135 sq mi of space.

- **Elkhart restricted area** releasing 164 sq mi to civil air traffic, was reduced to upper Lake Huron, Mich. Lake Huron region was reduced and restricted in use. These designations of 135 sq mi of the area.

- **Chesapeake Inlet, Willoughby Island, Va.**, has also been modified and cut from 142 to 98 sq mi.

- **Restricted corridor at Ft. Leonard Wood, Mo.**, has been lowered from 50,000 ft to 6,000 ft.

As a means of facilitating the public use of restricted airspace, FAA has designated civil aircraft operations of 17 of the present restricted areas. It will assume control of eight additional restricted areas Aug. 15. Over the 14 months since the program was initiated, total restricted and prohibited airspace from 140,824 to 156,000 sq mi.

CRAF Moving Toward Turbines

Washington—Civil Reserve Air Fleet contract and large proboscis aircraft will not guarantee an air carrier cargo aircraft contract in April 1960 and 1962, the Air Force warned last week.

Speaking to eight industry spokesmen representing the Air Transport Association, the Independent Airline Association and the Supplemental Air Carrier Conference, Assistant Secretary of the Air Force Philip H. Twine pointed out that removal of the "no defense requirements for commercial aircraft use" is a major objective.

Twine's comments were interpreted by the industry as a "go slow" signal toward a special regulation outlining the detailed information report by the controlling agency of each restricted area. A large volume of material was submitted to the FAA following requests of the regulation. In addition, surveys and consultations with the controlling agencies of the airspace under question resulted in further restrictions.

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Twine emphasized that the 1949 and the DC-7 will be "moved from the CRAF program as soon as the DC-7B and Douglas DC-10 are available to satisfy minimum passenger requirements. Procurement of this type aircraft in passenger configuration is being accelerated and it will be no longer necessary for a short period of time," Twine added.

Twine said that this moving also could be applied to purchases of DC-7B aircraft as well as the defense requirements for commercial aircraft use. "The CRAF program is a major objective," Twine said.

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LaGuardia Safety Survey by Pilots May Determine Cutback Demands

By David H. Hoffman

New York—An airline pilots' survey of possible flight hazards around LaGuardia Airport's 15th runway construction project may result in demands for significant traffic cutbacks at the terminal base.

Quadrantiers, distributed last month to about 1,500 Trans World Airlines pilots, will determine whether Air Line Pilots Assn. headquarters commands further operational restrictions for LaGuardia, the nation's fifth busiest airport in 1959.

Procedures issued in the past 18 months, at the very least, pilots are overwhelmingly in favor of leaving LaGuardia's present minimum 600 ft ceiling and 15 ft visibility, which would require the airport to accept the worst of both worlds.

Moving last week in Boston, TWA's Master Executive Council considered that other pilot organizations, which, if adopted, would allow the port of arrivals and departures at LaGuardia.

- **Restricting** the airport to day operations only during the period of peak construction.
- **Rolling out IFR** (instrument flight rules) operations under the airport's 115 runway, 4-21, in response to November.

- **Reducing** the maximum altitude allowed for landing and takeoff of all aircraft to 1,000 ft.
- **Using** the air scheduled aircraft operating into LaGuardia to coordinate their flight to nearby fields and to avoid the airport and the construction program is complete.

The air carriers—American, TWA, United, Eastern, Capital and Northeast—already have shifted their LaGuardia flight patterns to minimize traffic loads on the airport's congested runway and congested parking area.

In addition, traffic through the terminal has been cut back to the extent of about 84 plane movements per day. In January, 1959, to illustrate, there were 12,477 landings and takeoffs at LaGuardia. Last January there were 11,121. During June, 1959, the report showed 38,252 plane movements as opposed to 33,991 in June, 1960.

Many airline pilots feel that LaGuardia's past facilities project is compromising flying safety at the airport (AWP Aug. 18, p. 10). These few complaints center on the shortening of Runway 15-43, which was reduced from 5,954 ft to 4,908 ft shortly after Runway 4-21 was shut down.

Pilots maintain that Lockheed Super

Combs and Douglas DC-7s, even though weight limited to 155,000 lb, cannot operate safely from a 4,908 ft runway unless all other factors—wind, weather and airport facilities—are taken into account. At LaGuardia such is not often the case.

Rather than shutting Runway 15-43, the 15 ft, unobstructed that permits the runway's northwest edge, across a hostile effect that actually exaggerates the impact of crosswinds, according to some pilots. Moreover, poorly lighted or neglected taxiways complicate night operations. The same applies to the old radio conditions that no longer match the state of LaGuardia's changed ramp area.

Most airlines approaches to the airport follow the LaGuardia 115 runway, which is the surface used in contact with landing Runway 15-43 is closed, or at above the 600 ft altitude minimum. At this point, pilots heading to the northwest turn sharply to a downwind heading and 150 deg. before entering Runway 15-43.

Aircraft heading to the southeast, however, circle LaGuardia on the ILS and then execute a gradual 270 deg. left turn around Runway Island that, the pilots contend, leaves them dangerously close to a 622 ft field storage tank and five 231 ft. tank islands in the three.

The Federal Aviation Agency, which approved the 600 ft ceiling approach, says that standard obstruction clearance is not provided. Pilots, on the other hand, point out that an obstacle, seemingly at 7 in. could lead to a collision with the Runway tank, which is a relatively small obstacle on the ceiling approach to Runway 13.

ALPA will last month its recommendations to the FAA, the current and the Port of New York Authority. ALPA officials had discussed the possibility of a waiver of the present ceiling, but the FAA's decision on the matter is pending.

Aeroflot Begins Flying Second Siberian Route

Moscow—Aeroflot has started pouring flights over its new northern trans-Siberian route between Moscow and the Soviet Far East.

First transport to Russia the new route is Aeroflot's 101. It flies from Moscow to Khabarovsk via Selykhan, Nizhny and Yekaterinburg. The new route approximates the frequently delayed "double tracking" of the existing trans-Siberian service from

Eastern Orders 720s

Washington—Eastern Air Lines placed a \$14 million order for 18 Boeing 720 jet delivery on scheduled to be completed in 1960, and the carrier said it will have meeting tonight orders on all other aircraft orders at the time. Eastern plane order is for the 720, equipped with Pratt & Whitney J402-10, 4000 HP, J402-10 engines, shortly or later than through a separate cooperative financial for the program.

Moscow to Khabarovsk and Vladivostok via Selykhan, Omsk, Novosibirsk, Krasnoyarsk and Irkutsk.

With the alternate route available, planes flying across Siberia can either fly north or south on the existing landing terminals to be made closed airports.

When in full operation, the northern route will extend beyond Yakutsk, to Magadan. At Magadan some planes will arrive, Khabarovsk, Khabarovsk, and others will go south to Khabarovsk.

Aeroflot estimates that the northern route, which will cover the Arctic Circle, will be completed by the end of 1960. It will be a route between Moscow and Yakutsk. Distance used between Moscow and Khabarovsk—about 1,000 sq mi—will be over 1,000 sq mi.

TWA Florida Route Confirmed by Board

Washington—Civil Aeronautics Board upheld Trans World Airlines' authority to serve Florida from St. Louis and Kansas City last week, but the Board said it would not allow the service from the West Coast at the result of a court decision.

CAB recently granted TWA's authority to operate scheduled service from the West Coast to Florida with a stop at Kansas City or St. Louis. Complaints from Delta Air Lines and Eastern Air Lines to the U. S. Court of Appeals led to a decision by TWA's Board to change service at Kansas City, St. Louis or Nashville, Tenn.

Court and the Board might "impose such a restriction upon the route between TWA and St. Louis as to ensure that it would not be an effective competitive with any single-flight, single carrier transcontinental route which might result from the Southern Transcontinental route."

CAB Vice Chairman Charles Connors dissented from the Board decision to uphold TWA's authority, saying he was "convinced that this route does not warrant an additional monopoly route."

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Seaboard and Western Creditors Participate in Refinancing Plan

New York—Creditors of Seaboard and Western Airlines last week agreed to participate in a refinancing plan for the airline that includes a vote for them in its management.

Canadian Air Canada, Ltd., has since Seaboard has ordered the GL-1 turboprop transport, East Coast Corp. for fuel, and Calkins-Wright Division of Curtiss-Wright Corp. for piston engines for its Convolution aircraft. Also involved are two aircraft firms: AirWorld Leases and Intercontinental Aviation Corp.

New Bing!

Richard M. Jellison, former associate of Lawrence S. Bucklehill, was elected general manager and acting chairman of the board and Peter J. And, chartered accountant with Canadair, was elected a board member, increasing its board from six to eight members. Both Jellison titles are new to the company. Raymond A. Norden remains as president.

- **Issuance of \$13 million of 48 year nonconvertible debentures to major creditors, who will make additional advances to the carrier.**
- **Sale of \$1,576,000 of 6% 10 year S&P A debentures to the public on a best-efforts basis by Carl M. Lisch, Rhoads & Co. The debentures are convertible into new common stock at \$1 a share and also carry five year warrants to purchase at \$5 a share 1664 shares of stock for each \$1,000 principal amount of debentures.**

- Reverse 1-for-3 split of the parent 1,500,000 shares of stock issued, reducing outstanding shares to approximately 500,000

- Offering to percent stockholders of two new shares for each new share held

Purchasers of the Series A debentures

ago to purchase an additional amount of another series of debentures, known as Series B, if the offering of new stock to stockholders fails to raise \$2 million—the Series A bonds to provide the difference. The Series B debentures are convertible to stock at \$3 a share, but

To provide immediate funds to meet Seibford's critical housing demands, Canadian, Han and Curtis Wright and a small group of private investors have purchased \$2 million in temporary debentures which are exchangeable for Seaboard's debentures and warrants.

Series A and B debentures will carry voting rights equal to the number of shares into which they are convertible.

which might give the creditors considerable voice in selection of management in addition to its influence on policy through board members.

At the end of 1910 Seaboard had about 99½ million in short and long term debts (AWM 54a.2, p. 187). Seaboard was not all of this debt, which included unsecured notes payable to suppliers, which will be, instead.

If all the offerings are fully subscribed, Seaboard would raise \$6.8 million—\$2 million for new stock, \$3.1 million for the nonconvertible debentures and \$1,700,000 on the convertible debentures.

Since the debenture offering is on a best-efforts basis, the company is not

British Shift Jet Noise Emphasis

London—Major switch in emphasis in Britain's jet engine work towards programs from jet engines to intake noise suppression has been made to meet the growing noise threat during takeoff maneuvers.

¹Wash. at the National Gun Violence Establishment was a wholly concerted effort on the suppression of upstream noise, propaganda from the conspiracy artists in the use of variable geometry.

Various engineering arrangements currently are being evaluated whereby, during paraffinetic operations, the intake is choked to the bulk, making the

relative values of the α are same with respect to the black.

award of missing the full extent as it would be when an underwriting syndicate brings out an issue on a non-random basis.

Authorized capitalization of the company would be raised to 4,500,000 shares to cover possible future debt-to-equity conversions and warrant purchases.

Seeded in 1993, to three second place. Two Super Constitutions are 15 space engines are listed from Alliance Games, which is not a party to the financing proposal as it stands now. This has copies next year. Two Super Constitutions are listed from Air World Games, one of the agents, and one Super Constitution and four space engines are listed from International another agent.

factious is not a coalition's representative in the shareholder management. As a management consultant, he is regarded more as bringing a neutral, outside viewpoint to the company.

phonon contribution according to the structure model (d.f.HK) are

Suppression is conspicuously effected by slowing the jet speed or shortening the paid signature. A slow jet is the feature of the fine engines and fast local signatures velocities is the principal mechanism of most suppressants as its name should not contain.

Combination of jet suppression on a high air flow engine could effect a significant noise reduction of about 10 dB and in some according to Karol inherent configurations. On this basis, suppressor-equipped low engines would be much quieter than piston engines.

Open Enrollment

But, according to some operators, the drug problem is still serious. Some have been fined or arrested and reports suggest that on the East Coast the street opening rate has increased by as much as 5% in the absence of enforcement.

For this reason, separate fee for the papers are viewed as unlikely.

The Establishment is an experiment with 1,600 persons and using refined techniques, has confirmed the empirical methods of measuring personal income levels established by Holt, Berenski, and Newman's experiments in the Fort Belknap Reservation. The results were agreed with a 60% confidence interval, but the methods and efforts involved did not allow the distinction between leadiness and dishonesty (11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831,



HOW A PISTON PIN THAT LOOKED LIKE THIS PROVED ENGINES ARE SMARTER THAN SOME PEOPLE

An overhauled R-985 engine was being shop-tested. During the check-out a new piston pin failed. Damage to the power section was extensive... expensive, too. Beds and pistons were broken. Although the frustrated you might have looked like a Pratt & Whitney Aircraft original equipment part, the engine soon detected its inextinguishable defect.

The steel in the look-alike pin lacked sufficient hardness. Its specification had been since been discovered by Pratt & Whitney Aircraft engineers. Through continuous research, experiment, redesigning and testing, a steel better able to cope with extremes in wear and fatigue had been specified.

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SHORTLINES

► **Acrobates Argentina** has taken delivery of the sixth and final of five Conquest 4 helicopter orders in its order.

The Conquest 4, powered by four Turbomeca Aspa engines, has been in operation on the Argentine state airline since May, 1978, on European routes and since June, 1979, on U.S.-South American service. The company reports a 90% increase in revenues in the first six months of Conquest 4 operation.

► **East Coast Flying Service, Inc.**, a contract carrier and fixed base operator in Westborough, MA, has received the largest of three contracts from the National Aeronautics and Space Administration for air service between Langley AFB, VA, and Patrick AFB, FL. East Coast's contract is for \$215,703.10 and calls for four monthly invoice runs. Capital Airways received a similar contract from NASA for \$168,911.23 and South East Aircraft Corp. received a contract for \$115,000.

► **Federal Aviation Agency** has increased the rate between overhaul on the Pratt & Whitney Aircraft R-3500 piston aircraft engine from 2,000 hr. to 2,500 hr. The engine is used on Cessna 440, 440B and 440C, all variants of the Douglas DC-6 and Martin 404s.

► **Florida Air Lines of Spain** has reduced its domestic fares by approximately 15 to 20% by adjusting the official International Air Transport Association exchange rate, which stands at 60 pesetas to \$1.

► **KLM Royal Dutch Airlines** reports operating revenues for the 12 months period ending June 30, 1980, of \$150.1 million, an increase of 12% over the previous fiscal year. Net income for the period was \$14.9 million, compared with \$5.5 million for the previous year.

► **Lines International Aeronautica, S. A.**, has been recommended for a temporary foreign air carrier permit by a Civil Aeronautics Board examiner to operate air service from Guayaquil and Quito Ecuador, on Havana, Cuba, and Miami, with the stop authority at Panama City and San Andres Island, and from Guayaquil and Quito to Bogota and Miami with flag stop authority at Jamaica.

► **Mohawk Airlines** has stated its intention to operate a new morning route from Elmira, N. Y., to Washington, D. C. The route would extend from Elmhurst, N. Y., to Washington via Albany, N. Y., and Elmira, bypassing the change of airlines now required for passengers flying between Washington and Elmira and Boston.

AIRLINE OBSERVER

► **British government** is ready to place a detailed design contract with British manufacturers for the development of a supersonic transport plane that will work in collaboration with foreign companies in undertaking the project. Ministry of Aviation will select one of the two aircraft groups and one of the two engine groups to pursue the work of design detail. At the present time, the government is discussing with the four groups financial and other issues under which the project will be developed. Feasibility studies have included a Mach 2 light aircraft project and a Mach 2 stratospheric aircraft. However, no strong design studies will be covered with both groups until the program reaches a stage where a firm decision can be reached.

► **Soviet airline Aeroflot** says it handled 50% more passengers during the first half of 1980 than in the same period last year. The carrier says it exceeded its passenger traffic goal for the six months by 15%. Given a number of passengers carried was the largest for any full-year period in Aeroflot history, although percentage increases are declining. The 1980 goal for the first six months of 1980 compared with a 97.5% increase in the first quarter of 1980, a 40% gain for the entire year of 1979, 50% in 1978 and 60% in 1977.

► **Registration of John Bonavia** in traffic director of International Air Transport Association, in sharing industry-wide attention because of the regulations toward the airline. The registration was not voluntary but was required by Director General Sir William F. Hildred, who urged the IATA Executive Committee to ask for Bonavia's resignation. Bonavia insists the strong support of a wide number of airline officials who feel his ability has done much toward maintaining stability and providing compensation in controversial rate and line issues that have plagued the IATA Traffic Conference in recent years.

► **No-show problem** on evening flights is growing at New York International Airport because of difficulty in making close connections between widely scattered terminal buildings at the airport.

► **Negotiations** between the U. S. and Philippines and Mexico on bilateral air transport agreements have been resumed. Meanwhile, Douglas is making its DC-10 as the Mexican market with obvious strong that air carrier for three years be placed shortly by Aeromexico de Mexico. Mexican market now stands to begin U. S. foreign based market, with U. S. market spending more money annually in Mexico than any other country. Travelers from Mexico account for 18% of all U. S. income from foreign visitors, a total amount only to receipts from Canada.

► **Federal Bureau of Investigation** has received 35 individuals charged with false travel claims since Aug. 1. Approximately 1,000 bonds have been forfeited have been investigated by the FBI since July, 1979, when the Department of Aircraft or Motor Vehicle Records was approved.

► **Delegation of 11 Soviet civil aviation specialists** arrived in Washington last week for a three-week visit of offices and airport facilities in Washington, New York, Boston and Miami. They are under the direction of the Federal Aviation Agency. A similar U. S. delegation, headed by FAA Administrator F. R. Gossard, will visit the Soviet Union for a proposed three-week tour beginning Sept. 19.

► **Japan Air Lines** will cut passenger rates on domestic routes 10% by early fall. Carriers will begin Douglas DC-8 helicopter service between Tokyo and San Francisco Aug. 12 and will gradually move Douglas DC-7s and DC-8s from international routes to domestic operations.

► **Norwegian Airlines** is losing back the five Douglas DC-7s it traded to Douglas Aircraft Co. as part payment on five DC-8s. The leased contract is effective through March. Replacement of new Northwest Lockheed Electra has for aircraft (Aug. 4, p. 37) and increased traffic passengers made the move necessary.

WHAT'S IN YOUR AIR CARGO FUTURE...

PROBLEMS? OR PROFITS?

Route pattern complexities of typical airlines demand a cargo aircraft with the capability of operating over both short and long route segments with excellent economy and turning ability. The Canadair Forty Four will do this for you! It combines the air cargo freighter base with the long range aircraft to provide a standardized economic fleet unit. The Forty Four will give you profit-making operations, at current rates, over route segments as short as 100 miles and as long as 5,000 miles.

This is the type of flexibility that will answer the many and varied problems confronting airline operators who, because of the growing demands of shippers, are being forced to provide a combination of short, medium and long range air cargo services for the commercial freighter at attractive and competitive tariffs. In this situation, the Canadair Forty Four offers constant economy and earning ability over the complete range of route structures that must be provided in the collection and distribution of air cargo.

Practical applications of this are found in the short route cargo aircraft that are necessary to the supply and distribution of goods to various terminal points of trans-continental and trans-Atlantic services. This is evident because the major cities of the Eastern United States and between the principal points of Europe. These inter-city routes are essential enroute to the long haul trunk service, and with the Forty Four can be handled without a change of aircraft.

The need for this system of short, medium and long range operations will develop through the growing awareness among business establishments that the cargo of air cargo by air is becoming an essential element in the overall marketing program. This will open up new markets, give to transportation companies new and more profitable services. The Forty Four, with its flexibility of performance, can carry cargo at a profit over the whole distance spectrum—short, medium and long range, and has the aerial performance characteristics to get in and out at 45° of the world's major airports. These are decisive advantages in favor of the Forty Four.

SOME RUNWAY AND PAYLOAD SPECIFICS ON THE FORTY FOUR

1. From current no-short as 6,000 feet, can operate with 70% payload up to single dimension of 3,000 miles.
2. Can operate from 80% of the world's major airports, with due consideration to both runway length and allowable wheel loading.
3. Will seem an operating profit with load factors as low as 30%.
4. Breakdown load factors in the Forty Four represent low loads on larger proposed equipment.
5. Breakdown load factors on larger proposed equipment represent major profit potentials on the Forty Four.
6. Can operate non-stop on the London-New York route with an average annual payload of over 50,000 lbs.

CANADAIR LIMITED, MONTREAL, CANADIAN DIVISION OF **GENERAL DYNAMICS**



BEIGIAN Red Cross workers, Boy Scouts and police gather in line to fill refugees as disembarking from Sabena DC-4.

Sabena Faces Route Crisis After Airlift

By Cecil Bravaker

Brussels—Sabena Belgium World Airways may face a severe crisis for the longer alone and beyond the substantial increase last December from its emergency Congo refugee airlift that closed away aircraft from its most lucrative markets.

Sabena's attempt to find a solution to its problems also may mean increased competition for other carriers over routes that already are highly competitive.

If the present Congo leadership was out in its determination to ease all traces of Belgium rule both economic and military, a vital link in Sabena's network will be severed, one that even in the years has accounted for approximately 45% of the carrier's annual revenue.

Before the Congo uprising, the Belgium carrier served a total of 45 cities and towns within Africa. 17 of these are its former protectorate, with a network totaling approximately 11,200 mi. Other Sabena routes linking Brussels and Africa amounted to another 116,000 mi. Possible irremovable loss of these routes, which represent about one-third of the airline's total route structure, is a matter of major concern to top Sabena officials who, at the same time, must cope with the day-to-day problems of providing an airlift to the Congo and maintaining a semblance of commercial service.

These officials hope that somewhere, some way, the Luxembourg government will be replaced by a pro-Western, more importantly, pro-Belgian—regime. If that happens, they hope that the province of Katanga, with its mining interests and modern jet airport at Elisabethville, will remain loyal and open.

They are under no illusion, however,

that either of these intentions will be easily attained. If all the facts Sabena will turn its efforts to other areas, notably the South American market which already has a lustrous reputation with new and severe competition. The carrier also probably will again strengthen its bond to the Far Eastern market and within Europe.

Sabena also knows that should it be forced from the Congo, there will be no lack of willing buyers. Possible new routes include Western carriers already operating extensions within the African network as well as politically motivated lines. Carriers who are particularly conspicuous are Air France, which apparently is searching for a strong foothold in the area.

Intensive Effort

Intensive aerial effort by Sabena spanned 10 days between July 9 and July 13 when the airlift effort in the Congo and the halt in flow of Belgian troop reinforcements to the area permitted the carrier to put almost all its aircraft back into commercial service.

Because of the confusion which it caused the airlift pattern from which it day and the lack of complete information on flights within the borders of the Congo, its competitors were extremely in yet available in the financial loss the refugee airlift has or will, entail for Sabena and the Belgian government as a whole.

But there is no doubt that it will be staggering. Between July 9 and July 13, when Sabena began shifting some of the airlift planes back into commercial service, the airline had committed its full fleet of five Boeing 707-120 turboprop transport and eight Douglas DC-4's plus 17 DC-6's and 450 and new DC-4 into the emergency operation (AW July 23, p. 38).

Within the Congo, the carrier also turned its fleet of four DC-4s, four Convair 440 Metropolitan and 13 DC-3s and C-47s to the task of shuttling refugees from the interior to safe evacuation points in Leopoldville, Tshombeville and the Belgian military base at Kinshasa in the central Congo.

Part to the airlift Sabena in the North Atlantic since had been scheduling a total of 13 mixed trips per week with 10% between Brussels and New York, with two of the flights stopping at Montreal.

Combined east and westbound passenger load factors for these flights—each with 150-160 seats and 115 emergency seats—had been averaging 65% during the summer tourist season now in full swing.

Considering only the 11 direct round trips between Brussels and New York, and applying the basic 5200 emergency seats to all 91 seats occupied during an average round-trip flight, the airline lost over 500,000 seats per week in potential gross passenger revenue, less in the route between July 9 and July 22.

Over 40 Sabena's five 707s had been following a schedule of 24 round trips per week—eight to Leopoldville, seven to Elisabethville, and two to Johannesburg, South Africa, three to Moscow, and the 13 North Atlantic flights.

The DC-7Cs, DC-6s and 450s used in the airlift were pulled back into scheduled service within Europe and to Moscow, Leopoldville and the North East, including Congo, Ankara, Athens and Tel Aviv.

In addition to the loss of its own revenues and the burden of the airlift itself, Sabena has been forced to supplement its efforts by chartering aircraft from other airlines to aid in the crisis.

WORLD'S LARGEST JET FLEET

Of Boeing 707 Intercontinental Jets and Caravelle Jets!



WORLD'S LARGEST AIRLINE

Connecting 216 Cities, 76 Countries and 5 Continents

17 BOEING INTERCONTINENTALS. 24 CARAVELLES. World's largest fleet of these two superb jets. They fly the fastest long range and fastest medium range jets in the skies today. And all 41 will be in service by the end of 1960.

These are not just ordinary jets. Air France Intercontinentals and Caravelles are the most thoroughly tested airplanes ever used in commercial aviation. They are the kind of jets you'd expect to find on Air France.

Air France has been flying jets since 1953. That means we've got long years of priceless experience for pilots... ground crews... technicians. In fact, every Air France pilot flies the Atlantic has more than 10,000 hours of experience. And we have technicians, under Air France's precise standards, who take her for a check every 2 months; make sure she's right every 6 months. Important facts to remember when you fly the world's largest airline on your next trip abroad.

AIR FRANCE JET

WORLD'S LARGEST AIRLINE/WORLD'S MOST PERSONAL SERVICE



Aeroflot Begins Helicopter Service at Moscow

Aeroflot has inaugurated scheduled passenger helicopter service linking Sheremetyevo International Airport with Moscow. Later service will also be available to and from Vnukovo Airport which now handles domestic flights exclusively. According to the announced schedule, Mi-4 helicopters carrying up to 11 passengers make 13.12 round trips daily between Sheremetyevo Central Airport in the suburbs of Moscow and Sheremetyevo. At present, travel time by bus or by train at least an hour and sometimes more from Sheremetyevo to the center of

Moscow. Helicopters make the bus to Gorki Airport in approximately 12 min., according to officials. Thus, passengers can take a taxi or a subway the remaining 41 mi. into the center of Moscow. Flight is made at 300 ft altitude. Central Airport, closer to Moscow city, includes complete loading space, restaurant, ticket office, waiting room and telephones (center). Aeroflot officials plan to operate type services to nearby resort areas such as Pskovsk, Krasnodar and Rostov. Aeroflot has begun passenger to central airport (below).



city and to fill in major gaps in the European route structure, which it has tried to support throughout the Congo emergency.

Continued activities participating in the evacuation from the Congo have included Air France's Airbus Central African Airman of Rhodesia, Ethiopian Airlines, KLM, Royal Dutch Airlines, Lufthansa German Airlines, Sabena, a Belgian non-scheduled airline; Israeli, Tunis Moroccan Airlines; a Lebanese charter service; Transair Swedish charter airline; and Union Aeronautique de Transport de France.

A significant portion of the refugee evacuation program has been taken over by USAF flying Lockheed C-141 transport transporters and Douglas C-124A (AW) 74, p. 37) but for the water land has remained with Sabena.

During the airlift Sabena ferried out a total of 25,711 passengers including 25,596 adults, 8,127 children and 1,885 infants in a total of 209 flights—42 with 707s, 46 with DC-7Cs, 31 with DC-6s and DC-6Bs. Other carriers, including USAF, transported a total of 8,773 refugees from the Congo Republic during the period. Sabena aircraft logged

a total of 6,117 airlift flight hours.

All Sabena aircraft in the airlift have been converted to all-weather configurations, with 188 seats fitted in almost every 707. Since passengers are only permitted to carry a maximum of baggage, about 400, for a period, the amount of the Congo airport was almost an unknown factor. The 707s often took off with more than 700 persons aboard, children sitting two and three abreast in the aisle and on chest seats, infants wedged between boomers that had been hung from the ceiling. Highest figure to date for a single 707

but born 305-291 passengers and 10 crew members.

On a typical day, five Sabena 707 flights would leave the Congo along with seven DC-7Cs and eight DC-6 flights carrying a total of approximately 3,500 passengers.

In general, both aircraft and crews were expected to be rugged. A 707 averaged one round trip flight per day between Brussels and the Congo, flying a total distance of 7,215 mi. in a five-day run that ranged between 14-5 and 16 hr. depending upon weather and winds.

Progressive line maintenance checks were suspended throughout, but they were limited into smaller increments. A 707 due for a check requiring three hours, for example, would be limited to a "banger" like a C-47 flight, given the first half of the check, left the yard and pulled out to prepare for another flight to the Congo. On its return, it would be pulled back again for the second half of the check, finally leaving it after its third flight from the Congo.

Flight crews followed the same pattern. Of Sabena's 750 total wing capacity and last officers did were assigned to the airlift, and each crew took its place from Brussels to the Congo and returned with it.

707 Reaving

A 707 crew took the seven-eight hour flight to Leopoldville, remained there for about two hours while the aircraft was refueled and loaded, and then climbed back into the cockpit for the return roundtrip flight to Belgium.

The crews of the piston-engine aircraft, the initial two parties. The DC-7s, with a maximum of 100 passengers, were scheduled to fly to Leopoldville in about 14 hr. the DC-6 in approximately 17 hr. After a grueling flight over the jungles of Africa, the crew then was directed to take off again, landing on croquet at points within the interior and leaving from back again to Leopoldville. Elizabethville, Kinshasa or other collection points. Then, when the aircraft was loaded, the crew began the grand back to Brussels.

Most crews, once back in Belgium, had at least a two-day layover before being called upon again to begin the long haul back to the Congo. And, according to Sabena officials, there was little or no complaining, with the air crews recognizing the human aspects of their mission and seeking their own.

Schedulers for both the airlift and commercial service were worked out as a day-to-day basis, depending on the situation and the number of flights which are to be evacuated and their location, on the second on the number of Sabena aircraft to be available, the flights with

the heavier loadings and, therefore, priority, and the number of flights which could find support by taking over specific flights. The schedules often are shifted no more than 12 hr. before the first flights were to begin on the following day.

European Service

Most of its European service during this period was the five Congo-414 Sabena bus on the contract planes on DC-4 from its Congo fleet that happened to be in Brussels in a spare aircraft at the time the crisis began. Operating the least possible time on the ground—passengers were sometimes called for one flight as their 140 tons to the trip to release London's aircraft flow duty to London, Paris, New York, Glasgow, Manchester, New and other ports.

If these aircraft were not available for a scheduled flight, Sabena looked for another carrier that had either a parallel flight or an aircraft available in Brussels long enough for a flight to be maneuvered in during the situation.

Almost all European airlines that touch Brussels, according to which took over one Brussels-Munich flight, came to Sabena's aid at one time or another.

On any particular day, as many as 11 of 16 planned flights may have to be canceled, with other carriers taking over some that remain. On a second day these airlines helped fill the gap.



CL-44 Fuselage Section Mounted in Water Tank

Canadian CL-44 fuselage section is mounted in water tank at Montreal, Quebec, for static and fatigue testing. External loads are hydraulically applied to the airframe section which is fully instrumented to measure stress levels, loads and deflections. The fuselage section is connected from control bulkheads to simulate the effect of a wing in flight. Rear section of 140-ft tank has a lateral extension to permit motion of CL-44's wing tank.

- Olympic Airways took over a flight to Athens.
- KLM assumed responsibility for a Brussels flight.
- British European Airways flew the three Sabena schedules to London.
- Scandinavian Airlines System took over as the Amsterdam-Copenhagen run.
- Alitalia flew to Rome for Sabena.
- Swiss Air Lines of Zurich made a flight to Bern and Paris.
- Swissair picked up a Zurich flight.
- In all such flights, Sabena had attempted to put one of its own aircraft even ahead to complement the regular crew as an effort to retain at least a portion of its passenger identity.

Return to Service

With demands for an all-out effort at any cost apparently on the decline in the situation specified in Congo, Sabena officials were hesitantly re-evaluating their situation as to scheduled service.

Cong 707 was pushed back into the Brussels-New York route with a schedule of one round trip per day a round was begun during the period to Leopoldville, ensuring that refugees on its return. DC-7Cs were to begin reverse flights to Elizabethville via Athens or Rome, Congo and Houston, again before the first Congo flight resumes. The large public, however, the question of Sabena's future in Africa, still remains.

Douglas Offers New Caravelle Version

New York-Douglas Aircraft Co., which began a U.S. sales demonstration tour for the 3rd Caravelle jet transport last week, will offer three versions of the aircraft including a new Caravelle VII. Based on the Caravelle VII-B, powered by the Rolls-Royce Avon 513A turbojet with greater thrust than United Air Lines has ordered, and the Caravelle VII-C is powered by the General Electric CF6-50-21D jet engines. Douglas will also offer the engine powered by the Rolls-Royce RB168-31A turbojet engine.

Latest specifications, stated by Douglas Aircraft Co., show identical performance for the Caravelle VII and VII-B. These versions will be 1 ft. 4 in. longer than the 101 ft. long Caravelle VI and will carry 78 passengers (total) about compared with the 72 in the Caravelle VI. In its first-class configuration the longer airplane will carry 68 passengers in against 64 in the Caravelle VI, and 90 all lowest passengers compared with 80 in the shorter aircraft.

Caravelle Speeds, Range

Maximum speed of the Caravelle VII and VII-B of 535 mph, a 10 mph faster than the earlier version. Range with full passenger load increases from 3,930 mi. in the Caravelle VI to 3,130 mi. Takeoff distance (on level standard air) at 6,500 ft. for the Caravelle VI, 4,400 ft. for the Caravelle VII and 4,500 ft. for the Caravelle VII-B. Landing distances are 4,500 ft. for the VI and 4,350 ft. for the other two.

Maximum gross weight of the General Electric-powered Caravelle VII is increased in the latest specifications to 114,640 lb. from 110,230 lb. quoted earlier (AW May 2, p. 118), and maximum landing weight rose from 104,270 lb. to 109,170 lb. The same weights are specified for the Caravelle VII-B.

Percent of the VII and VIII in the same-10,220 lb.—compared with 10,560 lb. for the Caravelle VI.

Douglas is leasing an airplane bought by General Electric and delivered to GE late last week. The airplane is a Caravelle III which will be taken to Edwards AFB, Calif., at the end of the Douglas sales tour Aug. 16, where its power Rolls-Royce 513A engines will be applied at GE's flight test center with the company's test engines. Douglas has a \$2.1 million contract to deliver five pods, static and related equipment for the engine tests.

GE will use the airplane in a demonstration for its engines, as an additional flight tested for the engines, and possibly eventually for a corporate transport. Three of the five pods will go to Sud, two for installation on the



REDUCED COCKPIT is in on the Caravelle VII-B and later series will increase visibility. Molding of the new nose (below) compared with the present (above) indicates how front windshield panel will be lengthened and side windows increased in size and modified in shape. Seats are moved forward also a visibility aid. Instrument panel and overhead panel is reworked and communication and navigation control boxes will be brought down from the overhead and mounted on the pedestal.



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GENERAL ELECTIC will fit the Caravelle III with CF6B-31 turbo engines later this year, using the engine as a demonstrator and for engine testing.

first Caravelle VII and out for static test.

The GE Caravelle, with the CF6B-31 engines, will not become a Caravelle VII, but heads retaining the short fuselage it will not have the redesigned cockpit that will be incorporated beginning with the VI-A version.

Earlier models still use what is commonly a Canard nose, but the new cockpit, while retaining the aerodynamic shape of the airplane nose, will have considerably greater visibility. The front windshield panel will be increased in height and the side panels will be larger, of different shape and configuration. Wind tunnel tests will be moved forward as a result.

The instrument panel will be laid out to avoid duplication of the instruments, and the instrument layout will be changed. Communications equipment will be brought down to the console from the overhead, which itself will be completely modified for other equipment, including two rows of warning lights just above the front windshield.

Douglas plans now scheduled to demonstrate the latest airplane to airlines and local service carriers in New York, Boston, Montreal, Washington, Miami, Dallas, Kansas City, St. Louis, Chicago, Tulsa, Minneapolis, Denver, Vancouver, Seattle, San Francisco and Los Angeles. Ground Air Lines maintenance personnel will also be introduced to the new plane.

Douglas is preparing delivery of the VI-A version in the fall of 1968. If enough orders are received, and the GE powerplant version enters the following year or possibly even in late 1967.

Federal Aviation Agency has accepted formal certification of the Caravelle after three changes were made.

Passenger emergency oxygen system with automatic pop-out feature in case of cabin depressurization at altitude was modified.

Cockpit controls for landing gear and flap were repositioned, separating them from the pedestal.

Flap pusher and control surface actuator was modified to U. S. standards.

Caravelle Pilot Checks

Federal Aviation Agency is requiring that test pilots demonstrating General Electric new fuel Ararat Caravelle twin turbojet transport planes U. S. type ratings in the month.

When General Electric, in cooperation with Douglas Aircraft Co., first pilots of industry spokesman aviation safety flights in the Caravelle in New York in the September of a U. S. after test FAA inspectors pilot side along. After meeting themselves in the month, the FAA inspectors then worked as check pilot in two type ratings in the Douglas plane who earlier had qualified on the Caravelle in France.

To comply with FAA's three-hour minimum time requirement for the Caravelle, Douglas also had to fit in a company-owned flight inspection time. Caravelle before flying the demonstration flights.

CAB Blames Explosion For National Accident

Washington—Civil Aeronautics Board has found that detonation of dynamite in the passenger cabin was the probable cause of a Northwest Airlines DC-8 crash Jan. 6 near Bolivia, N. C., in which 29 passengers and a crew of five were killed.

In an accident report, the Board said that a dynamite charge was exploded while the plane was in normal flight after passing the Carolina Beach "It" beach break of Wilmington, N. C. The charge was detonated by means of a dry cell battery which also was used as a unit occupied by Mr. James A. Erick, the report said.

The Board emphasized, however, that no reference is made "in the report concerning the placing of the dynamite aboard the aircraft or of the person or persons responsible for its detonation." It said the criminal aspects of the accident were referred to the FBI for handling.

SONIC VIBRATION PROBLEMS ON DC-8 SOLVED BY BLIND BOLTS



Blind bolts shown permit short cylindrical stress test (1000 psi max. 78 x 1/2 inch) without blind hole. One or three blind bolts in each flange and fuselage. An hydraulic stress test may safely used in flight wing areas for repairs on failed aircraft. Blind bolts may also be used.



Blind Bolts were finally selected by Douglas DC-8 engineers for use in the Sonic Suppressor. Extensive tests of various blind fasteners determined that Blind Bolts in temperatures could be used from overall sound pressure levels reaching 130 decibels.

In this unusual application, the remarkable ability to the Blind Bolt to resist sonic vibrations stems from several of its inherent design features: the even thickness technique, combining the oval lock of the Expander to grip the thread of the Core Bolt and the wedge lock between the Expander and Sleeve end; the hole filling ability, resulting from the expansion of the Sleeve chunk during the installation pull-up of the Expander into the Sleeve end; and finally, the inherent fracture resistance, gained from the high scale strength imposed by the Core Bolt and from the cushioning effect of composite laminar materials.

Because the coefficient of expansion must remain the same to prevent loss of interior preload, the compatibility of structural materials at high temperatures is essential. Inside the stainless steel flange above exhaust gases reach 900°F. A-304 stainless steel Blind Bolts are used. On the outside where structural temperatures reach 300°F, Type 431 stainless steel Blind Bolts are used.

From the shop viewpoint, Blind Bolts are installed rapidly and quality hole preparation is simple, no reaming is required. Only Blind Bolts offer a choice of gas during tests designed for repair or modification in difficult or tightly congested structural areas.

It was this combination of factors, plus the consideration Blind Bolts Wrote for freedom.

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Pilots Dr. Rorer and Morgan d'Ardenne (November 23, 1934), using a Montgolfier balloon, were the first to leave the earth to test man's physiologic reactions. The experience was the forerunner of extensive Space Medicine studies of today.

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Exploration into unknown areas such as Space Medicine, planetary studies, stimulation to imaginative scientists and creative engineers. Research at Lockheed's Missiles and Space Division covers the entire spectrum—from pure basic research to development work, in support of current projects. Space Medicine is but one phase of Lockheed's complete system capability in aviation and satellites. To maintain this position of leadership calls for an extensive research and development program—ranging from electrical propulsion research to advanced computer research, design and development. Typical current projects are: Man in space, oceanography, fuel cells, space stations, space navigation, solar wind effects.

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Industry Probes Nuclear Pulse Radiation

By Barry Miller

New York—False nuclear radiation which could temporarily disable avionics controls in a weapons system and thus jeopardize the success of the weapon's mission is becoming the subject of serious military and industry concern.

The extremely brief, but very high intensity pulses of radiation that occur immediately following a nuclear explosion can produce disrupting torques or static separation of aircraft equipment at distances from the detonation point that were once considered to be safe for commerce.

Disposal: Nondischargeable

Although the total radiation dosage of high intensity pulsed is negligible, and is of magnitude less than that which would permanently destroy equipment, it can produce malfunctions in some circuits. The equipment was altered

quently recover from the temporary disturbances, but in certain types of circuitry and equipment the functions can be harmed. For example, a pulse of radiation might scramble the memory of a computer in a missile guidance system or may temporarily trigger a disarming circuit which would threaten the guidance system off. Or the malfunction might temporarily block radio transmissions from a satellite in a space vehicle. Electronic transients produced by radiation pulses conceivably could permanently destroy microcircuits.

Previously, heat and blast were regarded as the nuclear explosion's deadliest threats to avionic equipment. For this equipment to be permanently disabled or destroyed by cumulative radiation dosages, it would have to be located within the destructive zones of blast and heat effects. More recently there has been growing awareness that neutron radiation effects can effectively extend the destructive range of the

plation for microseconds in time through parasitic effects on key equipments.

In spite of the problem becoming particularly acute on the short end of the spectrum, the authors think a good amount of reduction. Hence, an experiment started about 100 ms from a time magnetic explosion in water—well beyond the onset of thermal drag—would be subject to genuine radiation rates up to 10^7 mc/cm² or higher, sufficient to produce severe thinning in various components and crystals, according to a recent report by W. R. Laugel of General Electric Co.'s General Engineering Laboratory in Schenectady. For an electrical discharge in air, the equipment would have to be within two miles of the explosion to experience the same critical radiation rate.

Eckigpreis mit Werbung

Specific examples where radiation induced transient effects might cause equipment failure at longer distances from an explosion are cited by Langdon and John R. Crittenden of GE's Tebe Department, Orono, Me. These include:

- * Subsonic supersonic air defence missiles with multiple warheads. If the first warhead warhead detonates well out in space, midcourse pulses could double confidence on other missiles, thereby ensuring successful missiles to nullification. Transition attack could then prevent missiles from being lost in close misses.
- * Nuclear explosion near aircraft. A high-speed aircraft flying outside the destructive range of a nuclear explosion might experience a loss of control from shock waves could be difficult to detect. The possibility of an aircraft being first shot then hit by a nuclear warhead might nullification because of a false induced descent.

Temporary reallocations produced by nuclear pulses extend the life probability of a nuclear weapon fired by an enemy in space. Nuclear pulse effects also might be a critical factor in Project Orion type nuclear rocket propulsion schemes.

Two accompanying charts, prepared by Critchfield on the basis of the Langston report, illustrate how public nuclear effects, as peak dose rates, effectively increase the destructive range of a one megaton nuclear explosion in space. Critchfield chose the upper or conserving estimate of the threshold of susceptibility for various components to nuclear explosion effects.

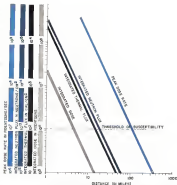
Might weapons makers supply—such as Boeing Aerospace Co., a prime contractor on the Minuteman II B2B and the B-52C air defense missile—by studying those patchy studies, calculating effects on various components and systems. The addition was of Boeing's AeroSpace Division dates back to 1965, according to Dr. Glenn E. Reiter. During its first three years, that Boeing group's primary concern was with potential damage to components from vibration, but later test the more complex studies to transmit reduction of effects. Moreover for the company's interest, Dr. Reiter indicates it is to be able to design equipment which will function in a much wider mission area.

Boring's work is funded by a variety of government agencies. Air Force supports its contract work, and Air Force is a major customer. Among the government agencies known to be supporting studies of treatment as well as prevention, include offices at the Wright Air Development Division, Air Force Special Weapons Center, Army Ordnance Corps, Army Signal Corps, Naval Ordnance Fire Laboratory, Navy Bureau of Weapons and the Atomic Energy Commission. Companies conducting research work include leading pulp reduction efforts by American Cyanamid, and General Electric, and General Electric's High-Speed Corrosion and General Atomic division of General Dynamics Corp., Lockheed Aircraft International Business Machines, Fidelity Corporation and Clet, Inc., Seattle, Wash.

Radiation Hazards

Estimated thresholds of acceptability of seismic drivers to energy released in a nuclear explosion, according to W. R. Lanyon, General Electric Co., are as follows:

- **Peak In Rate—12 to 18 months**—new service transactions may be produced in service components and circuits at these data rates, monolithically, circuits should be designed allowing sufficient time for transient conditions.
- **Integrated Design—30 to 195 cent** post base material use without grossly limit designs but ultrathin films, cellulosic and some thermoplastic may experience property changes at the selected range.
- **Integrated Thermal Film—195 cent** materials. This value will quote most nonfluorinated materials, groups dark, in rough and smooth, and rough and smooth, design lengths, polished metals or other nonfluorinated, outside.



QUALITATIVE nature of *damage*, in respect mentioned, from energies released by an explosive within explosion in space is shown from distance from the detonation. Detonated bonded lead is conservative estimate of the fluence at which various air growth was influenced. From the interaction of the shocked air with detrital comp. but, peak pressure indicates that on a 0.1 m/sec. path can be seen to be sufficient to produce fragments in average composition of distances beyond 100 m from the explosion. Equipment could be within 5 m to retain permanent damage from interacting pressure fluctuations within 15 m to the total working distance to have transiently developed pressure reduction damage can be seen to be sufficient to have would destroy the equipment within 15 m. Chart was prepared at General Electric Co.

and the Radio Corporation of America. Estimates for total funding of these programs for Fiscal 1961 range upward from \$2 million. Most of the programs are understood to be one and two man efforts, although several are considerably larger. Boring's, for instance, presently employs 27 people.

Radiation Curing

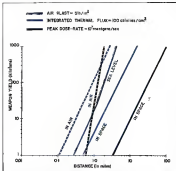
Radiation effects are generally divided into two categories. These are permanent damage, which persists undiminished for long periods after radiation onset, and transient effects, which disappear quickly after initial exposure to radiation, according to J. D. Mares of Space Technology Laboratories (for work with the Radiation Research Group of IBM's Military Products Division).

Permanent damage is caused by displacement and/or rearrangement of atoms or groups of atoms in a material while transient effects occur due to electronic excitation without atomic displacement. Usually, permanent damage

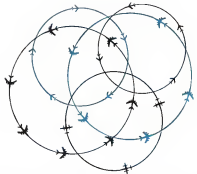
depends on the total, or integrated, radiation dose received and is commonly called the dose effect. Transient effects on the other hand may depend on the dose per pulse. Mice used in an earlier study dose rate and are frequently referred to as rate effects. Assessment of facts have been the most extensively studied these transient effects.

It is difficult to find consensus among people working in this field as to the poverty of our efforts, the precise levels at which components corrode and cracks are impossible to treat and malfunction, as even in some cases whether specific components experience temporary blockage or perturbations in behavior, the precise nature of these perturbations, how long they last, etc.

One of the factors which makes it difficult for those working in this field to come to grips with the problem and to work out solutions is the relative lack of good statistical data on the behavior of components subjected to pulse radiation. This results from the difficulty of making accurate measurements of an



ABSTRACT Dependence of susceptibility of various components to nuclear radiation shown in this paper. Distances from nuclear explosion at which equipment may be damaged by heat or peak plasma radiation dose rate increase in space. Pulse radiation appears in the principal cause of damage in space; the principal cause of damage is not for low-yield explosions only. Reasons for increase in hazardous range of dose rates in space is the absence of air which absorbs gamma rays. Chart was prepared at GE.



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time and find a pulse, variation in measurement techniques and the reliability to precisely simulate this effect in test facilities, even on reactors designed to produce pulses of radiation.

Many pulse experiments are conducted on the Godiva reactor at Los Alamos. Godiva produces a pulse, similar to the positive alteration of a sine wave—about 50 microseconds wide at its 4 heights. The peak gamma dose rate is about 10^7 roentgens/sec., neutron dose rate is 10^4 neutrons/(cm²-sec.). Integrated neutron value is 10^4 or 10^5 neutrons/cm². The integrated effects are not sufficient to cause permanent damage to anything other than low speed transistors. Rise time characterizes the Godiva pulse generates Godiva from being a radiative variation of a weapon environment, at least not critics of those experiments said.

A reactor which the military believes more suitably meets its needs for simu-

lation of a weapon environment would have the following characteristics: neutron flux— 10^7 to 10^8 neutrons/(cm²-sec.); total neutron dosage— 10^4 to 10^5 neutrons/(cm²-sec.); gamma dose—100 roentgens/sec. to 10^4 roentgens; integrated gamma dosage— 10^3 to 10^4 roentgens; pulse duration—1 microsec. to 100 microsec. for neutrons and 10^3 sec. to 10 minutes for gamma rays.

Thompson gamma rays (gamma rays that accompany the fission process) are released at fissures) are the component of pulse radiation most apt to cause malfunctions of atomic circuits. Neutrons interact with bomb materials and the atmosphere, and thus speed is slowed. Langlois points out. The weapon pulse is under (microseconds rather than fractions) microseconds as such gamma rays and neutrons delayed in time. The weapon environment and their effects are typical at the time of peak gamma radiation. Gamma rays appear to be

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Major Microwave Installation Nears Completion

Micro-wave relay station at Snake Creek Island, Calif., being completed by Collins Radio's "Cross Division, across Pacific Marine Knight Station has 30 microwave transmitters and 30 microwave receivers. The microwave relay consists with range headquarters at Ft. Meigs, 31 mi. from Nevada Island, 31 mi., and with a receiver station at Ft. Aguirre, 69 mi. Southwest at Ft. Aguirre consists with spectrum building that which is 115 m. away.

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Meetings on Effects Of Pulse Radiation

The following reports or reports devoted to pulse radiation effects are scheduled during the next few weeks:

- "New Radiation from a Nuclear Explosion," a report by W. R. Langford, General Electric Co., Aug. 31, Pacific General Meeting of the American Institute of Electrical Engineers, San Diego, Calif.

- "The Effective Range of a Nuclear Explosion for Electronic Equipment," a report by John R. Calabrese, General Electric, Aug. 30, Western Electronic Show and Convention (WESCON), Los Angeles.

- "Failure of Digital Computers in the Environment of an Atomic Explosion," a report by Max Reinhold, Service Development Corp., Aug. 30, WESCON.

- "Transient Effects of Nuclear Radiation on Typical Electronic Systems," a report by John W. Clark and T. D. Blumstein, Hughes Aircraft Co., Aug. 30, WESCON.

- Second Air Force Pulse Radiation Effects Conference (classified meeting), Sept. 14-15, Albuquerque.

responsible for most transient effects although at least one researcher feels they may be equally significant.

Transient effects related to computers are believed to be due to variations produced by the gamma pulse ionization liberates charge carriers, thereby increasing conductivity. Thus some logic elements are excited. The magnitude of the change in conductivity is a function of dose rate.

An optimistic view of the transient radiation problem is expressed by William Baliga, who heads a 14-man Air Force sponsored effort in pulse radiation effects at IBM in Orange, N. Y. Three years ago, when the company's work began, Baliga says, he believed the efforts of a Collins-type environment group design problems which were insurmountable. Now, however, he doesn't believe that a breakthrough is required to design equipment to function through this environment.

The IBM group has conducted experiments at Collins four times a year for two-day test periods over the past three years. Normally, the experiment subjects about 10 channels of information on a Collins unit. Heavy demands on the Collins facility prevent its customers use by any single representative. Regal Corp. general, for example, point out that thousands of hours of information provide 10 hours of master work every six months.

Several groups frequently run tests



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SYLVANIA

Division of GENERAL TELEPHONE & ELECTRONICS



Flight Propulsion NEWS

A report about progress in research and products from the Flight Propulsion Division of the General Electric Company



RB-66 modified to accommodate General Electric CJ-305-23C, has been flying since February, 1966. Aircraft recently completed cross-country test.

Aft-fan Powered RB-66 Tours United States

EDWARDS AFB, Calif.—General Electric's turbofan-powered flight test Douglas RB-66 took off from here recently on a cross-country test which gave aviation observers their first opportunity to see and hear General Electric afterburner engines in action.

The tour was a continuation of flight tests begun in February, 1966, when two General Electric afterburner engines powered the modified RB-66 in the country's first all-turbine flight with American-made engines. The aircraft has demonstrated outstanding performance in subsequent tests.

During the first, observers were able to study the afterburner engine of alone range. The design employs the aft fan with G.E.'s proven basic gas generator to provide up to 60 per cent more takeoff thrust and an improvement in specific fuel consumption of up to 15 per cent over straight turbojet engines.

Following a one-day cross-country flight, the RB-66 made its first stop at Palm Springs Airport, Long Island. Elapsed flight time of five hours 10 minutes included 30 minutes holding, let down through 30,000 feet of clouds to a 1900 foot refuel, and three low-level flights.

From Palm Springs, the RB-66 flew to Andrews AFB in Washington, D.C. where government officials watched the aircraft's performance at low altitude. Later, they had a close look at the CJ-305-23 engines with nozzle doors open. At Wright-Patterson AFB the afterburner test, plus ground underway close scrutiny by Air Force officials. Most of the comments concerned the short takeoff run and over-all low noise level of the afterburner engines. Thrust readings

taken on the field further verified the unusually good noise level characteristics of the afterburner.

The test program also provided a demonstration of General Electric's 44-000 hydraulic constant-speed drive with afterburner engines. The system provides constant input speed for the shafts of a constant speed generator. The two shafts aboard the RB-66 are the units which completed General Electric's earlier turbojet flight test program. The same accessory package is used aboard the C-130 and C-119.

Afterburner tests were previously powered the RB-66 are scheduled to fly this fall on the General Electric 44-000 and early next year aboard General Electric's Canaveral VII. Other members of G.E.'s growing afterburner family now being considered by the aviation industry for military and commercial applications are the 4008 pound thrust-class CF700 and the 32-000 pound thrust-class MF238. This engine and other military versions of the afterburner engine will undergo a 90 per cent reduction of vibration reduction over straight turbojets.

Following a final stop at Webb, Kansas, the RB-66 returned home to Edwards AFB, California, to continue an extensive test program.

For additional details on General Electric's aft-fan flight test program, check GED-417 and 4193. Information on constant-speed drive systems is available in GEA-5495 or the CF700 in GED-2964, or on the MF238 in GED-3305. For information on all GE turbine engines check GED-8066. See caption.

Strategic Air Command Records Triple Launch of GAM-72 "Quail" Decoy Missile

EDWARDS AFB—A Strategic Air Command bomber has recorded a triple launch of three McDonnell GAM-72 "Quail" decoy missiles into free flight over the Edin Golf Test Range off the west coast of Florida.

This triple launch marked the first time a SAC crew has launched more than one "Quail" at the same time.

The decoy mission, powered by a General Electric J65 jet engine, is designed for release at "ceasefire" of the kind in order to penetrate and confuse enemy air defenses.

The airborne decoys are mounted on special racks in the bomb bay of the eight-jet B-52D. Small fan motors inside the body of the "Quail" until it is moved into launching position.



J65 powered GAM-72 "Quail" decoy missile simulates B-52 on enemy radar screens.

When the space-saving tandem nose cone for the decoys without interfering with other weapons carried by the SAC aircraft.

After launching, the missiles fly in different directions but at the same speed as the big SAC bomber—more than 600 mph.

Each "Quail" in free flight produces a "blip" on enemy radar screens like that of the mother aircraft. The enemy, confused by a series of misleading blips, is faced with the problem of determining which is the real bomber.

Eighty more than 10 feet long, the "Quail" has ingested electric energy meant to simulate the massive B-52D on radar screens.

When testing is complete, SAC B-52D's will be equipped with several GAM-72 "Quail" in all of two general GAM-72 "Quail" "Mixed Bag" multi-surface missiles.

For additional information on the J65's adaptability to missile and other applications, check GED-4095. See caption.

Canaveral VII Powerplant Test Program Under Way

TOULOUSE, France—Aircraft #42, the General Electric Canaveral, has been completed at Sud Aviation's Toulouse plant. Scheduled for mid-summer delivery, the ship will become the first afterburner C-130-23C powered Canaveral VII.

Meanwhile, around the world, 33 testing is under way at an accelerated pace. Here is a brief summary of tests under way or already completed.

At Toulouse, wind-tunnel tests of a 18 percent scale model and of a 10 percent Canaveral VII scale model have demonstrated excellent low-speed aerodynamic characteristics of the aircraft, nacelles, and thrust reverser.

At Amsterdam, the Netherlands, high-speed wind-tunnel testing has demonstrated excellent characteristics of the engine, nacelle, and thrust reverser.

At Santa Monica, California, Douglas Aircraft is testing a Canaveral VII engine nacelle in a -23C nacelle design ahead of schedule. Work to date has achieved some of installation.

At Edwards Air Force Base, California, General Electric has completed tests using a 25 percent scale model mounted on a gyron under the wing of a flight test F4D. Aerodynamic characteristics of the nacelle are excellent.

At Cincinnati, Ohio, static load testing of a -23C has demonstrated the engine capability to support the Canaveral VII nacelle. Thrust reverser configuration has been successfully tested using a 1/12th scale static nacelle, and thrust reverser model. At General Electric's Peabody, Ohio, facility, engine testing under test are demonstrating -23C and thrust reverser performance.

For additional Canaveral VII information, check GED-4175. Canaveral brochure also caption.

Scale-model thrust reverser tests using 1/12 scale model of the -23C installation on the Canaveral have confirmed design calculations.



Converted J65 thrust will power the Bell X-14 this year in a NASA test program.

General Electric's Small Engines Proving Versatile Power Source for VTOL Development

MOFFET AFB, Calif.—A variety of vertical takeoff and landing aircraft are now in development with versatile General Electric small gas turbine engines as the power source.

A British concept is being evaluated at Moffet Air Force Base, where a dry J65-140-04 combustion is undergoing wind-tunnel testing. Jet-powered lift fans hold promise for a second stage of VTOL configurations with the capability of taking off straight up, flying forward at high speeds, and hovering.

In another program, converted thrust from a J65 turbojet will power the Bell X-14, which NASA is using to test the feasibility of advanced propulsion and control techniques for VTOL and other future aircraft X-14 flight testing is programmed to take place this year.

General Electric's T86 turbojet engine is the powerplant for two experimental VTOL aircraft which are scheduled to fly this year. General Electric's 44-000 turbojet engine, delivery type, and engine-type propulsion. The Pratt & Whitney T406 turbojet engine is being tested at Edwards AFB on the wing of the X-14.

G.E. is also developing the T64 turbojet/turbofan engine. Designed to operate continuously from 45 degrees below to 115 degrees above the horizontal, the T64 is especially suited for flying VTOL applications.

For additional information on the J65, check GED-4095. Check GED-2965 for T86 information, SAE-115A for T64 details. See caption.

ENGINEERS—If flight propulsion engineering interests you, write to: 8 Memorial, Dept. 712, Professional Placement Center, 570 Lowland Avenue, New York, New York.

FOR MORE DETAILED INFORMATION on these and other developments in General Electric products, contact your nearest G.E. Flight Propulsion Division representative or, by mail, before the deadline you would like to receive.

General Electric Company
Science A204-1
Schmiedel, S. M. Y.

- ☐ GED-417 and 405 "Program Report"
- ☐ GED-4095 "Constant-Speed Drive"
- ☐ GED-2965 "T86-1 Turbojet"
- ☐ GED-4095 "44-000 Turbojet Power"
- ☐ GED-4095 "Jet Fan in Turbofan"
- ☐ GED-4095 "J65 Turbojet"
- ☐ GED-4095 "Canaveral VII"
- ☐ SAE-115A "General Electric T64"

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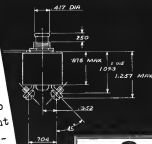
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simultaneously and it is possible, before any, for other equipment to interfere with test results of a particular group.

The IEM group has made observations on the following serious components:

• **Transformer-Leakage current I_L** is found to increase with increasing radio fan noise, reaching 100 microamperes. The I_L tends to follow the shape and time scale of Colson's 30° interference pattern. Some decrease in frequency (1-4) are found. However, higher frequency, thus less transient. Before and after measurements were to appear, appear to be far less susceptible to pulse effects than other insulation, especially power transformer.

• **Capacitor-When exposed to the least most seriously affected component. Radiated flux causes charge accumulation on the capacitor which appears to be discharging during operation. The capacitor discharge current can be generated if the insulation radiates is known. The rate of discharge**



Microwave Antenna Tower

Microscopic antenna tower, designed and fabricated by Agilent Systems, Inc. for use in the microwave antenna tower. The tower is made of aluminum and is 100 feet high. It is used for the measurement of the antenna radiation pattern.

AVIATION WEEK, August 8, 1960

PIONEERING IS OUR BUSINESS...

BENDIX OXYGEN SYSTEMS CHOSEN BY GERMAN AIR MINISTRY FOR F-104 SUPER STARFIGHTER



LIQUID OXYGEN SYSTEM

Bendix Type 225M 2-Flow Liquid Oxygen Converter with automatic shut-off and excessive overpressure safety valves for the F-104 is shown. For F-104, Bendix Type 225M 2-Flow Liquid Oxygen Converter with automatic shut-off and excessive overpressure safety valves for the F-104 is shown. For F-104, Bendix Type 225M 2-Flow Liquid Oxygen Converter with automatic shut-off and excessive overpressure safety valves for the F-104 is shown.



GASEOUS OXYGEN SYSTEM

Bendix Type 225M 2-Flow Liquid Oxygen Converter with automatic shut-off and excessive overpressure safety valves for the F-104 is shown. For F-104, Bendix Type 225M 2-Flow Liquid Oxygen Converter with automatic shut-off and excessive overpressure safety valves for the F-104 is shown.



EMERGENCY OXYGEN SYSTEM

Components of the emergency system which supply the pilot with oxygen in the event of a high altitude failure are shown. Bendix Type 225M 2-Flow Liquid Oxygen Converter with automatic shut-off and excessive overpressure safety valves for the F-104 is shown.

Bendix Type 1656 Rate of Climb Indicator, Type 3419 Accelerometer, and Type 3418 Fuel Flow Transmitter have also been selected for use on the Lockheed P-280. Specializing in Flight Instrumentation and Airborne Oxygen Systems for more than a quarter century, Bendix provides a wide range of military, commercial and private aircraft equipment. Oxygen systems and equipment in the high-performance aircraft meet the latest MIL-Specification. For complete information write:

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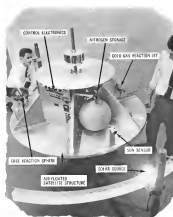
A single reaction sphere—electrically suspended—is the Bendix free wheel concept for space vehicle attitude control. Conceived to use the space environment to advantage, the free wheel concept eliminates the reliability problems of conventional reaction wheel bearings. Three static windings placed in orthogonal planes are employed to generate control torques around any axis of the rotor (and any axis of the space vehicle by reaction).

Free from bearing vibrations and gyroscopic cross-coupling, the free wheel provides a unique capability

for precision attitude control of orbiting scientific and military observatories.

This project is part of the over-all Bendix space-systems development program which includes satellite communication, satellite navigation, radiation-resistant electronics, magnetohydrodynamics, plasma shock tubes, and infrared reconnaissance.

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STABILIZATION IN SPACE

The Bendix stabilization system uses solid gas reaction jets for orbital orientation, and a free reaction sphere for fine control. Reaction jets each provide 25 pounds of thrust; launch reaction sphere provides torque resolution of 1 part in 10,000. Reaction elements, control computer, and reference sensors are mounted on a rigid satellite structure which is floated on a hydrogen gas pad to provide three degrees of freedom. A solar starlike source is moved around the satellite in test tracking assembly and separate Bendix structure balance may be adjusted within one-hundredth of an inch and moment of inertia matched to vehicle design.

This attitude control system is being developed to provide reliable stabilization to an economy of one-third second of arc for more than a year of continuous pointing life in space.

of capacitance is slower than the Codina pulse, and becomes larger for large voltages and capacitance.

• **Vacuum diode—Leakage** is observed with pulsing when the tube is back-biased. Information on the magnitude of the leakage is scanty and the effects of air saturation and other phenomena are not yet explained.

• **Tracers** (including remote tracers) and photodes—Tubes appear to perform well throughout the radiation bursts although there is some slight shift in $d \times t$ tracks.

• **Resistors**—No increases were observed in the values of carbon composition resistors (this is in contradiction to Spagel-Corbin work where such changes were observed). Changes were observed in the diode resistance; pulse toward resistors observed in air. Resistors in pulsing components are believed to experience some change in value.

• **Quartz crystals**—Changes probably due to ionization; pulses were noted in the magnitude of the output of a 307 kc crystal showing the frequency was unaffected within a measurement error of 1%.

Circuits Tested

A number of circuits were tested by the IBM group during its program. Inactive, transmission multivibrators, employing either germanium or silicon transistors, experienced complete chaos when subjected to Codina bursts. Radio-tagged circuits using 1 μ capacitors and high frequency inductors operated satisfactorily, indicating the importance of design techniques in accounting transient effects. A pulse test of a flip-flop dated for the Minnesota IBM and employing 2N7105 transistor was completed at a 10 kc rate and found to be free of transient, according to Boeing.

Theoretical radiation effects may limit the usefulness of some components such as semiconductor capacitance, infrared sensors and photo tubes, according to Kenneth Chris Koster. Ultimately, he says, design techniques should be used to minimize the damaging effects of radiation and thus, especially, with the availability of more information on transient radiation effects.

Lessening Radiation Effects

The effect of the transient pulse as a particular component or within design is not clear and uncertain. Scientists working in the field suggest the following to minimize or reduce the effects of radiation and thereby reduce the amount of heavy shielding required for outer equipment.

• Use reliable, resistant components, whenever possible designed to accept large noise pulses.

• Use radiation resistant materials, particularly germanium, which appear to

Bendix Systems Division

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AVIATION WEEK, August 6, 1960



Now
we will
listen to
stars
no telescope
can see

Strange sounds fill the heavens...sounds that can help us chart the universe for man's conquest of Space. To capture these sounds, the U.S. Navy is sponsoring one of the most imaginative projects man has ever conceived. It is a giant radio telescope that will listen to star billions of miles away...beyond the reach of even the most powerful optical telescopes.

Though of gargantuan proportions, this cosmic listening device is a fine precision instrument. The "ear," a massive yet lightweight aluminum dish antenna, is being built by the

Columbus Division of North American Aviation—one of the most complete systems-creating centers in the world.

The Columbus Division, with its advanced research and development facilities, has developed fine techniques for the construction of high-performance, low-cost antennas and complete radio telescope systems. These precision instruments will aid military and research organizations in detection, tracking, surveillance, and radio-astronomy...and contribute vitally to America's assault on Space.

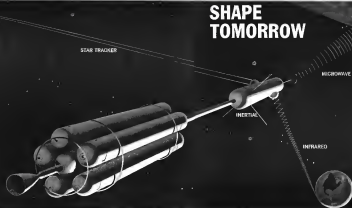
THE BIG "EAR"—The world's largest radio telescope is being built at the U.S. Naval Radio Research Station at Sugar Grove, West Virginia. It will tower to the height of a 10-story building. The massive reflector, designed by an

inertial guidance system, is 600 feet in diameter and more than seven acres in area. The 10-foot thick reflector, with a potential range of billions of light years, will be built by the Columbus Division of North American Aviation.

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DUAL, line-of-sight antennas for STAN Trk H.S. consist of broadcast arrays of vertical dipoles 50 ft. apart (left). Grade path west is at right.

Improved ILS System Operating at London

By John Tynan

London—Dual streamers systems are, fully transformed circuitry and constant impedance mechanical modulation are claimed to have significantly improved the reliability, stability and accuracy in a new instrument landing system inaugurated at London Airport last month.

Nosed STAN 7/3, the system has been adapted by the Ministry of Aviation for most of the recent civil aircraft in Britain following 12 months' evaluation of prototype equipment at Bournemouth.

Other STAN 7/8 equipments are currently being installed at Brussels and Zurich.

The system has been evolved by Standard Telephones and Cables, Ltd., from a military mobile equipment developed by the STC parent company in the United States for USAF in 1957. The ground station, which is fully duplicated, includes automatic and continuous full-time monitoring equipment, remote control, independent setting up controls and on-line test facilities for standby equipment. Cost of a complete installation is approximately \$125,000.

Directional accuracy of the narrow localizer beam has been raised to one and a half minutes of arc going plus and minus five feet diameter of the runway centre at touchdown. These accuracies, recorded by monitoring equipment at Haze, have not yet been

confirmed from this, not least if there are established the system could replace the leader rubber research needed to provide accurate information during the final approach and time in the British World Landmark system.

Antenna Array

Composite radiation pattern of four localized signal sources is generated by two independent antenna arrays which radiate two modulated carrier frequencies (ca. 9.5 kc) apart, each modulated with 50 cps, and 132 cps.

One of the antennas provides a highly defined, narrow approach beam 30 deg. either side of the runway center and extending to 75 m at 2,000 ft and 75 m at 10,000 ft. The two wide lobes on the carrier frequency form lobes on either side of the narrow and provide a five degree to eight sector. Keeping the directional beam narrow reduces the ground fluctuations which previously caused beam deviations due to ground reflections combining out of phase.

A smaller, narrower area provides the other pair of signal zones in the form of a narrow, V-shaped lobe extending outside the 70-deg sector of the directional lobes.

Besides providing one-directional navigational information and a back course facility, the Lufax labor office truly supports academy labor as

GCA Unit on Turntable Speeds Runway Shifts

Navy has mounted guard-controlled approach equipment on turrets at Naval Air Station, Dallas, and Marine Corps Air Station, Beaufort, which shifts courses in 1 min., covered with 20-30 min. when command had to be moved to another location.

induced by the directional transmission which creates false signals.

Sideband field strength of the directional antenna is less than 50% of the peak level when 10 deg off course and less than 10% of the peak strength at stations 12 deg off course. The current field strength is less than 50% off peak when 7 deg off course, less than 10% for stations 12 deg off course.

Mechanical Modulation

Inputs to the two independent omnithetron arrays are provided by two identical radio frequencies, and parallel sections Merckhoush, belated modulators which have the advantage of constant impedance provide the 90 and 135 cps modulations. With the modulator matrix the carrier wave does not pass through the modulator, and there is no phase modulation. Standing wave errors are eliminated.

Development of a mechanical modulation system was undertaken because it enables directional shift due to phase change between the modulating frequencies to be eliminated and a stable phase modulation. It is also much simpler and reliable.

Dual locality satrains consist of broadside arrays of horizontal wideband dipoles 50 ft apart. Directional arrays has 12 dipoles and consists a reflector 85 ft. wide 7 ft high. The dipoles spaced 10 ft apart are adjusted by an array

The glide path establishes a vertically oriented to the deceleration baseline.

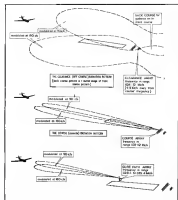
equipment turned through 90 deg. It radiates two signal patterns on a common carrier frequency, which overlap to form a sector width adjustable between 0.12 and 0.66 of the glide path angle, itself adjustable between two and a half and four degrees. Directional control within three minutes of arc is claimed for the glide path, which extends to 10 nm. (1)

Transmittance (%)

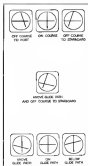
Checkout System Studies

Dayton-Undersand contracts for 10 monthly studies to determine Air Force storage standards and requirements for automatic checkout system in the F-15. 75 percent have been awarded by Wright Air Development Division to Martin, Minneapolis-Hennrich, Votco and Northern Douglas. AeroVot is teamed with Votco and International Business Machines Corp. will be associated with Northern.

Computers will replace automatic checkout equipment in use or under development for IT testing. AAAF was part of the effort to determine the type of maintenance which they are designed to provide at each operational level. Computers also will study expected weapons as the 1985-75 period, and recommend checkout system design philosophies that will be required. In the past, checkout system and maintenance philosophies have been established largely by the weapon system architect.



BAGMATON PATTERNS of SI'AN 7th distance zone, cross zone and slide with zone



FLS indications as re. aircraft using the RTAN 3.0 system are shown above.

Rocketdyne Tests New Solid Propellants

By Ernie J. Bohlen



30-IN. ROCKET MOTOR is prepared for checkout using the Calcutt 60 technology of Solid Propellant Operations. The apparatus will permit inspection of particle ends, the precise loading of the propellant to case and air tablets in the propellant setting.



AUTOMATIC WELDING unit, which utilizes a commercial welding apparatus, was designed by Rocketdyne engineers to handle outside and high-temperature work. The control panel (appearing on left foreground) can be moved outside of the booth for fully automatic remote operation.

McGregor, Tex.—Major gains in propellant mechanical properties have been achieved here by North American's Rocketdyne Division in a new family of variable rocket motor formulations which broaden the environmental capability of solid propellant rockets while not sacrificing critical performance.

The new rubber-tempered linear polybutadiene, Fluoradine propellants developed here by Rocketdyne Solid Propellant Operations (SPO) generally appear to be equal to or better than those based on other conventional binders, with respect to ballistic properties, and superior in its aging and mechanical properties, particularly at low temperatures. Included in these studies were polybutadiene styrene and neoprene (PBAS) and a copolymer of butadiene and methacrylonitrile (BAMNTP).

Intensive long-term testing shows these pertinent characteristics of the new Fluoradine family. SPO propellant laboratory group leader S. C. Barlow told AVIATION WEEK:

- **Capability of withstanding** temperature range of -75°F to 170°F with essentially constant elongation; at any given temperature and weight loading, Fluoradine has nearly twice the elongation of the corresponding PBAS formulation, thus advantage being greater at lower static loading than it is for the neoprene group maximum specific impulse.
- The new SPO family of propellants is said to retain its advantage in its elongation over the entire range of strain rates possible with an Avco high rate-of-strain sensor. At 0.77 in./in./sec. strain rate, for example, at -75°F elongation is 55%, at 170°F elongation is 52%, at 7.77 in./in./sec. strain rate, elongation is 50%.

- **Tear resistance** is approximately twice as good as the best of the current PBAS formulations, considerably offsetting processing losses including rammed separation. Also, in grain design, particularly in complex configurations, gains in providing high stress joints, Fluoradine's tear resistance allows design of grain features.

- **Shrink resistance** is tested excellent, and the formulation is said to resist almost completely from deformation resulting from shrink under compression. This characteristic, the reason why Solid Propellant Operations engineers here feel that they have the capability, using Fluoradine, of loading

2 million lb thrust single-grain rocket motors—a propellant that would possibly increase 15 ft in diameter to 65 ft in length and contain 350 tons of propellant.

- **Storage life** is not yet an outcome, but indications are that it will be at least equal to that of PBAS-based propellants. Barlow sees Fluoradine in easily taking a shelf life of five years and periods of up to 20 years should be possible, he indicated, admitting that the material is as yet too new to have an actual performance on aging capabilities available.

Specific impulse data is classified, but Barlow indicated that Fluoradine formulations provide a performance level which is competitive to any available solid propellant on the market today. This, he said, places the new family in the 245 specific impulse regime.

SPO's technicians are extremely conservative in discussing performance claims. They claim what they call the "sensible gain" in today's high-energy petro rocket motor propellant field, pointing out that increase of a point or two or three in specific impulse do not come readily by adding a pinch of cost exotic compound to the propellant formula. Many of the claims of gains of three, five or even 10 points often refer to theoretical specific impulses which are based on extremely small motor test thrusters and then extrapolated to large sizes, a practice which technicians say rarely stands up in their experience and use of which some refinements have become more in keeping.

Test Firings

SPO has fired its new propellant in several hundred test motor of 2, 3, 5 and 10-in. diam. with approximately 30-40 of the grains measured 18-in. in test motor, and technicians here consider it significant that their data has held up through the test program. Technicians say that SPO will soon get an opportunity to evaluate the new propellant in even larger motors. One of the service agencies has granted permission to load at least one of a series of 15-in. motors in a special static motor with Fluoradine. These motors will provide some 15,000 lb thrust over approximately 45-sec duration.

Ready availability is no repeat of that of the propellant in general. That formulation markets as the Fluoradine 950-series have been released to the pilot plants here, initially providing that technicians feel is a low base line covering basic design requirements with their carrying in solid loading structure specific impulse, and the fourth a special formulation incorporating a higher burning rate using catalysts.

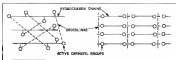
Pilot plant production capacity here at McGregor probably runs over 300-



PLASMA welding is applied to an experimental rocket motor nozzle to be tested by Solid Propellant Operations at McGregor, Tex. Coating permits high degree of erosion protection and use of new nozzle for numerous tests at great cost savings.



BUILDUP of 15,000-psi. research and development hardware shop includes PBAS engine boiler field that can handle rocket motor cases up to 73-in. in diameter and 36 ft long. Another pressure containing diagram (below) shows usual PBAS (left) and Fluoradine (right). PBAS shows machine number and spacing of reinforced groups. This, together with elongation (below) chart, detects final acceptability and gives sequential conclusions that promotes rigidity.



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Engineer checks out before starting engine in turbojet engine test cell.

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Write for Bulletin 391A-110.



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Transducer Division

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IMPROVED chlorine tests of new Floodyne propellant compared with PBAA is shown in cross-section of samples of each tested on an Instron apparatus.

300 lb month on a normal basis, which can be increased considerably as and. The facility is completely capable of cutting and evaluating rocket nozzles containing up to 10,000 lb of propellant. Avco Aero Space was told, in discussion up to 50-in and lengths up to 33 in.

Basic approach to the Floodyne formulation was to emphasize improved physical characteristics rather than attempt a major jump in performance, a slow, time-consuming process. Achieved was a new family of propellants, not merely an improved version of previous formulations.

One of Floodyne's prominent characteristics is the ability to provide a high degree of reproducibility. Lack of reproducibility of PBAA has posed a problem in that propellant family, in that each new lot, usually a few thousand pounds, of PBAA manufacturer must be made into test propellant to determine its acceptability, according to Burton.

This requires making a series of laboratory tests to determine optimum cure, since successive lots used differently 30 various cure systems. Basic cure is considered to be in the random molecular structure of epoxy-urethane binders and acrylics and. Test chain lengths and molecular weight are difficult to control to uniformly by current available polymerization techniques, SPO technicians state.

The active groups are inserted in the chains in random fashion and in random spacing. There are uncontrolled overhangs, in addition chains extending beyond the last carbonyl group and these tend to have the same effect as plasticizers.

A conventional electrostatic structure would be an ideal situation, SPO engineers contend. This type of structure is familiar in the curing of Floodyne

binders, whose molecules can be represented by lines of approximately uniform length, each having a carbonyl group at either end. This provides the requisite reproducibility and mechanical properties built in the propellant's binder polymer by use of synthesis techniques that involve controlling these polymer characteristics: intra-atom concentration of molecular weight arrangement, side chain content of the molecule, molecular weight and location of the active terminal groups.

Preformulation provided a comparison of PBAA and Floodyne binder polymers. Each had an initial viscosity of 420 poise. Nearly 40% of the PBAA, but only 12% of the Floodyne binder, had a viscosity of 100 poise or less. At the other extreme, 15% of the PBAA had a viscosity of 900 and 1,340 poise, while the Floodyne yielded no fraction with a viscosity greater than 780 poise. That same data for Floodyne binder indicates that molecular weight distribution apparently provides nearly identical distribution in Floodyne binders. The characteristics of the binder polymers provide the expected improvements anticipated in Floodyne binder as to reproducibility and mechanical properties.

Along with this polymer development was discovery and successful application of a chemical giving a superior cure to the new binder materials, after running with over 50% of solid substances as shelling up to 20% of auxiliary chemical used in Floodyne propellants.

The new propellants also exposed to randomly to control level and plasticity, the latter having only minor effects on tensile strength and elongation while providing major improvements in pot life and curability.

Indications are that the new propellant family will also be well-suited for use with reinforced plastic lightweight motor casings, which pose the problem of greater differentiation than lightweight metal cases. Greatly improved elonga-



GAS GENERATOR one (left), which is lighter and about one-third as costly to take care in the present conventional case, is an example of SPO development and research.

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Is ideal for use where space is limited or when a heavier transducer would accelerate test results. Low sensitivity to transverse accelerations and secure performance in any mounting plane make the 4-118 desirable for mobile tests. Output may be coupled to a recording oscillograph or the unit may be used with a vibration meter or oscilloscope. Write for Bulletin CEC 1235D-22.



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KM 474 mobile launcher made by Ford Machinery and Chemical Corp. for Army-Martin Pershing made its debut July 26.

Pershing Fired From Tactical Launcher

Washington-Army-Martin Pershing was fired for the first time from its tactical mobile launcher July 26 in the sixth successful short-range test of the missile in as many attempts.

The two-stage, solid propellant test vehicle covered a downrange target on its 30 mi. 250 sec. flight down the Atlantic Missile Range. First stage burned out approximately 40 sec. after launch. This was the third test in which wind velocities and directions were artificially varied and corrected while the test vehicle was in flight.

Test flight was the first made from the transport-erector-launcher (TEL) developed by Thompson Air Products Co., a subsidiary of Thompson Radio Wadsworth, for tactical use with Pershing in the field.

Special Test Range

An Pershing moves toward the longer range phase of its test program. The American World Airways, AMR operator, is completing construction of a special 11 station test range for the missile. When new range is completed because Pershing has no impact area other than the area used with previous missiles at AMR.

The 53 million Pershing stage can track 100 mi. from Cape Canaveral to Elephant and includes the new downrange stations. Each of the 11 stations is being instrumented with radar, long-range accuracy system (LOBAC), ultra

PERSHING is checked out before firing from mobile launcher July 26 at Cape Canaveral.



TAPCO POWER SYSTEMS

TAPCO HAS ENGINEERING AND MANUFACTURING EXPERIENCE IN SOLID PROPELLANT ROCKET NOZZLES

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ENGINEERING—For the past several years the Tapco Group has been working with solid rocket firms on development of both fixed and vectoring nozzles.

Tapco's work in this field has produced advancements in nozzle materials and techniques, including low-ablation reinforced plastics, refractory metal throats, and low torque, positive seals.

These projects are handled by an outstanding project engineering team, capable of proceeding from concept through prototype production on a tight schedule. This team is supported by heat transfer specialists, dynamics analysts, structures and materials experts, a large plastics laboratory and an advanced high-temperature metallurgy laboratory.

Advanced projects at Tapco offer excellent career opportunities for qualified engineers and scientists. Write Director of Professional Employment.



MANUFACTURING—The million-and-a-half square feet of the Tapco Cleveland plant contain all the direct and supporting equipment required for nozzle production on any scale, including a new 2500-ton reinforced plastics press for pressure-curing high density, low-ablation materials.

Each production nozzle program at Tapco is under the direction of a program manager. His job is to insure that quality and performance of products are constantly checked and rigidly maintained, and that the work is delivered on schedule.

Because of Tapco's nozzle engineering experience, customer-initiated design changes are efficiently handled. Changes are analyzed by the product engineering team, and are promptly phased into production.

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DESIGNERS AND MANUFACTURERS FOR THE AIRCRAFT, MISSILE AND SPACE, ORDNANCE, ELECTRONIC AND NUCLEAR INDUSTRIES

This 2500-ton reinforced plastics press, recently added to TAPCO's manufacturing facilities, can pressure-cure plastics up to 6 feet in diameter and 410 feet long.



high frequency doppler system (HDFP) and ballistic casing.

New streams will be at Mobile Center and Great Salt Cove on Grand Banks Island, and at Green Turtle Cove, Dundas Town and Great Swamp Cove on Great Abaco Island.

Existing streams being fitted with Pendang antennas include Jupiter, on the Florida mainland; North Riding Power, West End, Wilkie Gas, Little Cactus Gas and Allen Cove, all on Grand Banks Island; a site north of Dundas Town on Great Abaco; and Elephanta. Also being authorized for Pendang tests is the Twin Falls Veterans, a 46-ft. merchant ship being converted at Mobile, Ala., shipyard.

The 14-ft. Pendang, which has a diameter of approximately 90 in., is smaller, lighter and considerably easier to handle than the 61-ft., 65,000-lb. liquid-fueled Redstone which it will replace. Use of TEL instead of its own rocket motor is designed to provide full ballistic field usability with a self-contained system.

The tracked carrier, manufactured by Ford Motor and General Corp., is cited XMC-474. It weighs 11,000 lb. and has a speed of 40 mph. Dimensions are 33 1/2 ft. long, 76 in. high and 96 in. wide. Launching is an electro-mechanical system which the Army says can erect Pendang into firing position in minutes.

Daniel Chemical Corp. is motor contractor, and Eclipse-Powers Division of Bendis Corp. manufactures the all-steel guidance system for the launch.

Initial contracts for the Pendang system were awarded Mar. 25, 1958, and first launch was Feb. 25, 1960. Other firings were Apr. 28, May 30, June 9, June 20 and July 26. Four days of intensive development is expected before the end of this year.

The contract covers a part of overall Pendang development planned for the 1961 fiscal year. The \$70 million provides for engineering of engineering activities and procurement of long lead time items. Contracts covering other aspects of the Pendang program will be awarded later this year.

Transit III-A Launch Slated for November

Washington—Transit III-A experimental navigation satellite will be launched into a 28 day orbit from Cape Canaveral, Fla., in November and will carry a small payload satellite is Nov's second test at the dawn period technology (AVF) (p. 13, p. 14).

This will be the first Transit to carry a small-capacity memory device for receiving and transmitting orbital parameters. It will obtain data for use in

designing the full scale operational memory unit. Primary payload will transmit low doppler frequencies and store an electronic clock, as did Transit II-A. Army Map Service's SEODOR guidance equipment also will be tested in the main satellite.

A small satellite, attached to the main payload at launch and separated hours if an orbit, will carry a very low frequency radio experiment developed by Naval Research Laboratory. Launching vehicle will be a Thor-Able Star.

SE experiments in Transit II-A, which was launched June 22, have operated successfully. Navy and Naval Ordnance Test Station's related experiment transmitted June 27, as expected, and the Canadian plasma wave receiver experiment in the small satellite also noted as scheduled.

Army Reorganizes Missile Management

Washington—Army Ballistic Missile Agency last week secured management responsibility for seven additional programs in a shakeup at Army Ordnance Missile Command headquarters.

ABMA now will manage ballistic systems, which Army defines as those in which the subunit is fired on a set trajectory. Army Rocket and Guided Missile Agency will manage programs in which the path of the missile can be changed after launch.

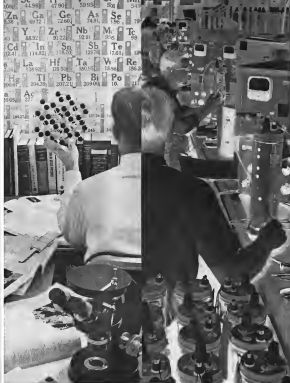
Task reassignments result in the transfer to ABMA from ARLGMA of Howitzer, Nike, Hawk, Corporal, Sergeant, Light Anti-Tank Weapon (LAW), Missile A and Missile B. ABMA will continue management of Redstone, Jupiter and Pendang systems. ARLGMA retains Nike Agen, Hercules and Zeus, Hawk, Redeye, Lacrosse and the Shilleagh.

McGuire and Otis Get First Bomarc-Bs

Washington—Air Force will install the first Boeing Bomarc-B air defense missiles at McGuire AFB, N. J., and Otis AFB, Miss.

Each site will have 28 launchers, to be built under the supervision of the Air Corps of Engineers. Both bases are operational with Bomarc-A missiles, McGuire having 56 Bomarc-A launchers and Otis 28. The Bomarc-A launchers damaged at McGuire when a rocket vehicle burst in June (AVF June 27, p. 23) currently is under repair.

Congress approved \$244 million for the Bomarc-B program last year after a House move to eliminate funding for the entire system. Bomarc-B has a solid propellant booster and can fly twice as fast in the 100 mi. range Bomarc-A.



MOTOROLA Military Electronics Division



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AERONAUTICAL ENGINEERING



GENERALIZED engine used to house the General Electric lift-fan during full-scale tests at NASA's Ames Research Center wind-tunnel in prototype jet transport, 400 mph pilot, VTOL close approach aircraft

Lift-Fan Engine Shows VTOL Potential

By J. S. Bots, Jr.



FAN ROTOR for GE lift-fan is made primarily of sheet metal. Rotor assembly being balanced alone has a tip speed of 710 ft/s. Fan pressure ratio is 1.175.

Washington—Highly successful full-scale wind-tunnel tests of an Ames General Electric lift-fan engine installed in a generalized aircraft configuration have established the general feasibility of this engine concept and demonstrated its potential for VTOL aircraft.

Twenty hours of tests performed during July in the 40 x 80 ft full-scale tunnel at the National Aeronautics and Space Administration's Ames Research Center have shown that the lift-fan concept has met the most optimistic estimates of its designers in its first combat tests.

G.E. believes lift-fan outflow, for the lift-fan engine, has improved considerably because two of the main uncertainties regarding the system have been answered positively by the Ames test and the ground running that preceded it. These uncertainties were:

- **Dilatation** of the air flow into the fan to be expelled during transient flight. As a VTOL aircraft moves horizontally after its vertical takeoff, the

air entering the fan has to make an increasingly sharp turn as forward speed increases. Theoretically, it could act to prevent absolutely that the fan into the fan would be blocked after the air makes the sharp turn. If the air tended to enter one side of the fan more than the other, blade loadings would fluctuate and vibrations would occur.

The Ames tests showed that even at virtually no flow, dilatation on the large installation tested there, up to forward speeds of 80 ft/s, which constantly over the complete transition flight phase for the fan configuration. Future tests will have to be made to prove that across flow dilatation would not occur if the fan were installed in a wing and did not have the long intake duct possible with a fuselage location. It is believed, however, based on the Ames results, the wing-mounted fan will not give trouble in this respect.

- **Installation weight** of the lift-fan system with its gas generator, drive shaft, valve, ducting, scroll and fan with its integrated tip turbine. Weight estimation on a system like this could considerably over or under years ago when they were in the paper stage. The G.E. lift-fan now running takes full advantage of the current state of the art in sheet metal construction and is considerably lighter than the majority of estimates used in the past in the preliminary design comparisons of VTOL aircraft. The present 70 in. dia fan coupled to a G.E. 357-T turbopump, plus the necessary ducting, etc., weighs 1,185 lb and produces 7,430 lb of lift thrust and 2,180 hp of horsepower thrust for cruise. Many hours of component testing and 43 h of ground running of the complete engine system plus the ground time at Ames indicate that the lift fan will have adequate life at its present weight.

Engine Matching Problem

The risk of lift-off to cruise thrust as the present lift-fan design is just about right for VTOL aircraft, which have always presented an engine matching problem because they need roughly three times more thrust during lift-off than they do at maximum speed. Thrust required by high performance aircraft for horizontal flight and maneuvering usually is about 0.75 of the lift-off weight.

If larger engines are used so that the thrust available is a little more than the lift-off weight and vertical lift-off is therefore possible, then the engines must be throttled back during cruise to such an extent that their operation is inefficient and fuel consumption increases.

If VTOL capability is achieved by adding extra engines and air ducting, lift-off and landing, then they must be turned at dead weight during horizontal



LOW-VELOCITY mass over the fan air cut on the bottom of the ducting. They have to the fan during transition flight in combination with the ducting valve which reduces the gas generator flow from the fan to a straight horizontal exhaust.



FEEDBACK inlet duct for the lift-fan is located sufficient air flow dilatation during complete transition flight in the Ames tunnel. Key design factor is elimination of air flow dilatation is a high velocity inlet flow and a fan pressure ratio above 1.1.

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permits to do continuous recording at high speeds
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small flight and the fuel load must be maintained.

Proponents of the lift-fan system believe that the practical demonstration by the GE engine has shown that it will provide VTOL capability with the smallest dead weight penalty of any known system. A major disadvantage of the system is the volume taken up by the fan, especially in a fuselage arrangement. Partial alleviation of this problem is planned by closing the fan as intake on the top of the fuselage with doors that swing open 180 deg. when the fan is operating.

A suitable amount of avionic gear and other equipment could be carried on the inside of these doors and partially lift the intake volume during high speed flight.

A rough example of what could be done with the GE lift-fan in its current configuration and weight using the gun-shaped aircraft shape that was tested at Ames is a small, four-engine VTOL observation aircraft capable of speeds above 400 mph. Such an aircraft would weigh about 5,500 lb., carry in the neighborhood of 800 lb. of reconnaissance equipment and operate at high speeds for about an hour. It would not be the most efficient reconnaissance aircraft from a weight-carrying standpoint but the performance penalty required to get vertical takeoff capability

is much less than that predicted a few years ago by many designers.

Engine failure during operation would be catastrophic on this type of aircraft, however, without some type of fast-starting emergency gas source to power the fan. Design philosophy today seems to favor large aircraft with either a single fan driven by two gas generators or two complete fan units similar to the one under test with independent ducting so one engine could drive both fans. Heavy duty landing gear probably would be required on these aircraft for emergency landings.

Large Diameter Fan

Tentatively, the GE lift-fan is described as a large diameter fan with a partial induction tip turbine. The hot gas drives the fan by passing through turbine blades on the tip of the fan blades. The gas is fed to the turbine through a scroll that extends only partially around the fan circumference. Another fan of this type is being developed in the free-world by Avco Aircraft of Canada for its saucer-shaped aircraft, which is based on its original development schedule.

Future potential of the lift-fan concept is considered very bright by GE engineers. They have made preliminary studies of fans that exceed 100 in. dia., which would be suitable for use in

large transports. These could be powered by T8, T54 or F19 gas generators.

Very light weight turbojet engines designed for lifting only have been studied in gas generators for fans. These gas generators plus associated accessories in the specific weight will result in thrust/weight ratios of 35 to 1, in the opinion of GE specialists. This could be translated into a substantial improvement in aircraft performance compared with one described above using the present lift-fan, which has a thrust/weight ratio of about 6.5 for lift. Almost immediate improvement of this figure to the range 7.5 to 9.0 can be made according to GE estimates by substituting a dual number of the J65 gas generator and lift fan installation improvements.

A flight test program will be required for complete demonstration of the lift-fan's capability. The Avco wind tunnel tests indicated that the net aircraft configuration would remain stable and make a smooth transition from vertical to horizontal flight. During this transition the hot gas must be directed smoothly from the fan and exhausted horizontally in close coordination with a downward movement of the forward vanes on the fan exit, which turn the fan flow to the rear and add to the forward force. Although a flight test director valve was not used in the Avco

tests, its flow characteristics were simulated. The transition during landing from horizontal to vertical flight was also shown by the wind tunnel tests to be completely stable.

Flight Test Program

Complete picture on stability cannot be obtained from wind tunnel tests, even though the tests can expose major problems. There was no intention to get adequate design data for incorporating any type of propulsion system into a VTOL aircraft, whether it keeps its fuselage horizontal during transition or not. Expense of a vehicle and flight test program will make a sizable change in the funding requirement for the lift-fan development.

Approximately \$6 million has been spent on the lift-fan program to date. It originated in 1967 with preliminary design studies sponsored by the Army Transportation Corps. In May, 1968, the Transportation Corps let a contract to GE for the construction of an experimental fan and for a proof test through 40-50 lb. of ground running and for 20 in. of test in the NASA tunnel at Ames with the fan driven by a J65 engine.

Army expenditure on the program has totaled about \$3 million and the Air Force and General Electric have each put in approximately the same amount

of money. The Air Force financial assistance has been generally in the form of "contributing engineering" by which engineers on Air Force contracts are allowed to work briefly on work which is of potential value to USAF. The development of the direct valve for the system was sponsored by the Air Force through a \$400,000 contract. The J65 engine as the power was also made available by the Air Force. GE took its confidence in the potential of the system has been demonstrated through its investment.

Future of the lift-fan system, however, is closely hinged to its ability to keep costs low in a flight test program in general. Low priority has been given to VTOL development by the Department of Defense. Hence for the development of operational VTOL vehicles by the services during the early 1980's, have faded to the last six months. The Air Force decided to bypass VTOL for its new Tactical Air Command fighter (AWM, May 14, p. 28) and the Army and the navy in choosing a helicopter fan air test position close observation aircraft (AWM May 28, p. 31). These decisions to postpone operational VTOL vehicles through another round of development programs were made on Department of Defense level. Dr. Herbert Ynt, director of defense research and engineering, and specialists from his

office coordinated a technical evaluation of the VTOL program made on date and this evaluation indicated that an effort to develop operational VTOL vehicles with all of their necessary ground operations within five or six years would not be successful.

A VTOL policy and technical evaluation committee headed by Col. May of Dr. Ynt's office has been responsible since February, for constant review of the VTOL work of the three services, other government agencies, private companies and universities. The Army, Navy and Air Force have representation on this committee.

Committee Formed

An ad hoc committee has also been formed on the aircraft service review level to get a decision from the services on what type of VTOL transport can be built which would allow each of them to study and define their detailed engineering and operational requirements for this class of aircraft. Design and construction of this transport apparently will receive the bulk of VTOL funds during the next few years.

Lift-fan concept is not under serious consideration for the VTOL development program, which is currently planned around one of the VTOL systems already flight-tested. Those include the deferred algorithm, tilting

Undersea launch pad for sixteen Polaris missiles



A U.S. Navy Polaris submarine is a self-sufficient ocean base. It provides comfortable quarters for its hundred-man crew and carries supplies for several months. In its launching tubes—eight in each side, as shown in this cutaway model—will rest 16 Polaris missiles. But a Polaris sub differs from all other missile bases in one important respect: it can disappear from the face of the earth for weeks at a time. Though its profile in some depths will be unknown, its presence will be felt. For—should America ever be attacked—such Polaris subs could launch its 16 Polaris missiles in as many minutes. Lockheed is prime contractor and system manager for the Polaris missile.

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rotor, unfused rotor, rotating disc and air wing assembly that have flown successfully in the past (AVF Aug 1, p 12).

Many VTOL experts in the three services believe that a flight test at the lift fan is critical for at the earliest possible date so that this currently successful research program is pushed through and a final positive answer regarding its capability is obtained. If this philosophy is followed, it is possible that the lift-fan flight test program will be a joint venture of the three services and will make maximum possible use of available hardware by adapting the existing fan to an airborne re-convert use.

Such a lean test option vehicle would not reveal the exact capabilities of the motor but should answer the question of feasibility and provide valuable design data for an optimum air craft. Most important, too, it would keep only low and raise the probability of a continuation of the program.

The test configuration has been redefined back into the Ames full scale tunnel in October and GE is now being a second 75 in. dia fan for test running.

No decision has been reached on a flight test program.

Lift-fan designers must compromise between a desire to have small compact fans which are easily located structurally and a desire to get a high suction ratio, which is the ratio of take off lifting thrust of the fan to the thrust provided by the gas generator. A significant rise in suction ratio is possible when the diameter of the fan is increased but small compact fans require a high velocity exhaust stream and a high pressure ratio to provide a specified amount of lift. Small fans, even though they provide a lower suction ratio, will thus have a lower



SCROLL extending partially around the circumference of the fan looks just got to the test. Exhaust gases enter the scroll from the gas generator at about 2,000 ft. Lifting power of the system can be improved if more fuel is burned in duct just ahead of scroll.

diameter, have a lower weight per pound of thrust produced.

All fans are located in wings, the wing aspect ratio and wing loading restricts the size of fan that can be used. This in turn determines the fan disc loading, and suction ratio.

Free Pressure Ratio

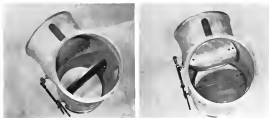
Radially fan altitude, subsonic air craft with good cruise characteristics will have free pressure ratios of 1.1 to 1.5, according to GE studies, as the best compromise between high suction ratio and small compact fans.

Burning fuel in the duct leading from the gas generator to the fan intake has also been studied to provide very large suction ratios out of small fans.

The auto-bearing appears possible but it increases duct design problems and complexity and raises the specific fuel consumption for the system.

One design problem that has been noted is the just as a ductwork to wing or fuselage lift fan was a device will face produced when the exhaust from the fan is forced at high speed under the aircraft.

This rapid flow caused a vortex of fuel between the aircraft and the ground creating a low pressure region that tended to hold the aircraft down. Most recent conversations with GE believe that this situation can be avoided with proper leading edge design, wing location and deflection plates and that down lift will not be a problem on operational vehicles.



DIVERTER valve shown is used to direct the hot air from the gas generator either to the lift fan or into a duct to provide hot air for thrust. The valve is then positioned to turn the flow 90 deg. into the fan scroll.



EARLY MACH 3 bomber design was rejected by USAF. Above: aircraft would have needed jettisonable outer wing tanks.

B-70 Will Create Enemy Defense Problems

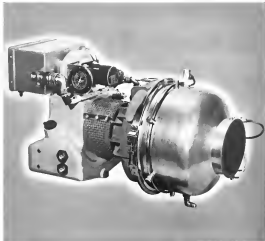
By Craig Lewis

Washington—High performance and flexibility of the North American B-70 will give the strategic bomber form a substantial increase in penetration capabilities, and this weapon will create serious new problems for enemy air defenses. Planned Mach 3 speed and 90,000 ft. penetration altitude of the B-70 could make all defense weapons in its sector, interceptors, missiles and force in earnest to meet heavily in air weapons and coastal defenses, according to an

analysis of the B-70 by the Senate Foreign Relations Subcommittee. Strategic Air Command estimates that a 510 billion investment in a fleet of B-70s would cost the Soviet Union 540 billion to improve defenses to compete with this fleet. The Senate report notes that "some thought should be given to the effect that a Soviet B-70 would have on our existing forces."

Speed alone is a valuable penetration aid, because it reduces exposure time and minimizes the number of air defense weapon systems which can reach

the attacking bomber. Even if a defense system reacts instantaneously, it is estimated that the Mach 3 bomber will be intercepted by only 11% of the number of weapons which will be able to reach an attacking Mach 1 bomber. Time delays in the defense system increase the B-70's advantage even more. These time delays stem basically from the time it takes to relay data through the defense control system and from ground radar problems in sorting out targets and getting them ready. B-70 should be able to equal the ad-



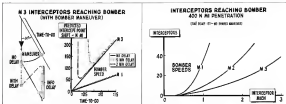
Multipurpose APU

New Solar gas turbine 80 hp APU is only 12½ in. in diameter x 25 in.—weighs 59 lb

SOLAR's new gas turbine powered multipurpose APU is ideally suited for airborne and ground power applications—in drive hydraulic, electric or pneumatic outputs for aircraft starters, fuel pumps and portable generator sets. The Titan engine has the highest power-to-weight ratio of any powerplant in its class. It is ideal for single-line multiple outputs from 25 hp to 60 hp.

The lightweight unit is simple to design, easy to maintain and can be started instantly—without warm-up—on temperatures from -60°F to 1200°F and under wide atmospheric conditions. It operates efficiently on a variety of fuels. Titan gas turbines are setting new standards of performance and reliability in propulsion units for commercial helicopters, in portable electric gener-

ators and in other applications. For details, write to Dept. PE-147, Solar Aircraft Company, San Diego 14, Calif.



B-70 MANEUVERING in a 30 day turn toward an attacking Mach 3 interceptor 15 sec. before planned intercept would be 225 sec. as from the predicted point at the planned intercept time. Number of interceptors meeting Mach 3 bomber are shown at right.

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Large Boeing B-70 D-30 turbojet engine, equipped with D-6 turbochargers, will be one of the most powerful engines ever built.



Four General Electric's bearings of tool steel take high temperatures, heavy loads, 5000 rpm and more.

A-6 turbochargers operate on air-driven turbochargers to drive compressor. Butterfly valves in turbochargers (shown) are equipped with Fafnir ball bearings.

Fafnir Ball Bearings of tool steel "beat the heat" in aircraft turbodrives

Two butterfly valves in General Electric's air-driven turbochargers control the pressure and flow of the air stream that reaches the turbine wheel. These valves must work with smoothness and precision for proper performance of the constant speed drive. Fafnir ball bearings help assure reliability.

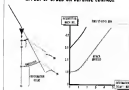
Made of chrome tungsten molybdenum tool steel, these Fafnir ball bearings are designed for load-free, precise performance under heavy loads, and

temperatures up to 1500°F. Their reliability has been proven by the remarkable performance record of the turbocharger units themselves, including constant operation around-the-world aboard the B-70.

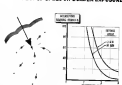
Fafnir's experience with high-temperature bearing requirements, and advanced work with exotic materials for increasingly critical needs, could supply bearing answers you need. Write The Fafnir Bearing Company, New Britain, Connecticut.



EFFECT OF SPEED ON DEFENSE CONTROL



EFFECT OF SPEED ON BOMBER EXPOSURE



Combined effects of bomber altitude and defense action delay on the intercept problem are shown at left. Chart at right shows the percentage of an intercept time needed by a Mach 3 bomber with defense action delay of two minutes and 10 min.

usage provided by its high performance through use of various electronic countermeasures and tactics to further reduce the response time of the defense against it will face.

Most of the current concepts for penetration in defense action have been based on the premise that an intercept in defense action is a two-step process: first, the intercepter must detect the bomber, and then it must intercept it. A Mach 3 bomber intercepting a B-70 bomber by 50%, while it would double the number of weapons needed, would not be a problem.

As bomber speed increases, so must intercepter speed increase to deal with the faster bomber. Consequently, equal number of Mach 1 and Mach 3 intercepters attempting to intercept a Mach 3 bomber, an operational area, have a 50% chance of intercepting it.

Any class of intercepter will get to intercept in three Mach 1 bombers in a Mach 3 bomber.

Any intercepter by an intercepting B-70 will create further problems for intercepter. For example, if a Mach 3 bomber makes a 30 deg turn toward an intercepting Mach 3 intercepter 15 min. before the predicted interception, the bomber will be 25% away from the predicted intercept point when the intercepter is engaged to take place. Any interception delay in getting data on the changed course to the intercepter will decrease its chance of catching the Mach 3 bomber.

Recent report estimates that with five minutes to go before an intercept, a B-70 making a 30 deg turn toward a Mach 3 intercepter will outrun it even if there is no time delay in the defense control system. It will catch a Mach 3 intercepter if there is a two-minute delay. A 30 deg turn away from a Mach 3 intercepter is estimated to preclude attack by the intercepter under any conditions.

Flexibility in penetration altitude given the B-70 an advantage and forces an intercepter to attack high and low level intercept.

The Mach 3 bomber will be able to fly below radar coverage in approaching an intercepter, then climb to cruise altitude and fly in its orbit at Mach 3. Once it is detected, a defense bomber is more limited in this aspect because it has to stay close to the altitude at which it is detected in order not to increase the time to target by losing speed during climb. Thus, the B-70 can expose time as well as flying above the intercepter's altitude of current defense weapons.

The B-70 design range of over 7,000 miles, with over 40,000 intercepting gives the bomber flexibility in its attack route and it has reached the same area from a great variety of angles.

Bomber can choose a variety of possible routes, as enemy must spread its defense area to increase its intercept to cover all a variety of attack.

Long range of the B-70 will make it adaptable for advanced intercept operations. A typical mission might involve flying off from a SAC base, in the northeast U.S., flying north to a selected intercepter, then proceeding to the area for 15 to 20 hr. After a second intercept, the B-70 would cruise at selected speed toward enemy territory, and it no longer had enough fuel to reach its target. If the mission was given to attack before the point was reached, the bomber would go to its target at Mach 3. If it received no attack order before its fuel was depleted, it would fly to its base.

Although it was not built to a prototype flight test program last December.

ENGINE INSTALLATION



B-70 will be powered by six General Electric B70 engines and turbochargers.

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For more information, contact Radiation Incorporated, 1000 North 10th Street, Suite 100, Arlington, Texas 76010.



RADIATION
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the B-70 project now is eligible for more intensive development with extra funds made available by Congress. There are only the latest items in the long history of the B-70 program.

This program got under way in the result of a general operational requirement issued in October, 1954, for a chemical-fueled aircraft based on to replace the B-52 in the 1965/70 period. It was labeled "Warrior System 110A" and the first wing of 30 aircraft was to be made in 1961. WS 110A was to cruise at Mach 3-4, then make a 1,000 ft penetration at higher speed. High altitude was an important objective, along with highest possible supersonic speed during penetration.

In June, 1955, the USAF decided to staff the development ordered WS 110A into development as a competitive Phase I program. Earlier that year, a requirement was issued for an environmental reconnaissance system with similar objectives. In July, this system became WS 110L, and the two programs were combined as WS 110 A/L.

Program Proposals

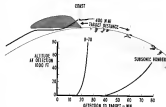
Of six aircraft manufacturers deemed eligible for the WS 110 project, only Boeing, Douglas, and North American Aviation submitted proposals. Both companies got Phase I contracts in November, 1957. First flight for March, 1961, and equipping of the first SAC wing in December, 1961. Meanwhile, ARDC headquarters postponed start date for the first operational wing from 1961 to July, 1964.

Boeing and North American submitted their preliminary design proposals, and the Air Force began studying the progress of two jobs in May, 1956. ARDC earlier had halted work on the WS 110L phase of the program pending a decision. This phase was never resumed.

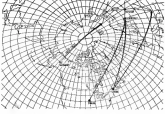
After prolonged study, USAF decided in October to discontinue Phase I development and permit the companies to continue work only in a reduced research and developmental basis. Some group points out that this effectively ended the program and that this action came directly as a result of dissatisfaction with the company's proposals. The designs were considered too cumbersome, and USAF suggested that future effort include investigation of high escape, take and boundary layer control to reduce weight.

After taking another look at the problem, Boeing and North American independently reached the conclusion that with high escape take based in the atmosphere, WS 110A could become an all-weather cruise bomber. This was reported in July, 1957, and

EFFECT OF ALTITUDE ON DETECTION



PENETRATION ROUTE FLEXIBILITY



Time between detection and arrival at target as a function of altitude at which the bomber is detected by ground radar is shown at top. Map below shows penetration routes.

the companies went into a second competitive design effort that fall, using new system characteristics. The proposals were received, and the Air Force decided the North American design was superior. The company got a Phase I design contract in December.

Program Acceleration

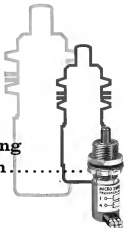
ARDC and Air Materiel Command stroked ways of accelerating the program and found an 18 month acceleration to the first testing schedule was possible. They recommended buying the entire weapons system, except the engine, through North American.

General Electric Co. was to supply the engine. This approach for accelerating the program was approved, and North American got a letter contract in prime contract in January, 1958.

In April ARDC and SAC met with North American in a B-70 Weapon System Evaluation Conference at which the aircraft design was changed. Most significant change was increased takeoff weight to more fully exploit the thrust and release capacity and to increase any future retrofit. In May, later that month, Boeing's Mach 3-4, which had been developing a bombing mission system, was also approved.



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tract for WS 100A, become a subcontractor to North American.

The B-70 Weapon System Development Engineering Inspection was conducted in March, 1970, and during that review, the 199 USAF personnel requested 764 changes. A review of these changes appears indicated that only 331 would be properly accomplished under the then current contract, and 95% of those had been made by Dec. 3, 1969. Mockup review was conducted in April, and 97% of the 15 changes then requested indicated also had been completed by December.

Engine Changes

An F105 cancelled the GE J45 engine which was to have high energy fans in its afterburner. During the B-70 development program, the USAF cancelled the J45 which burns JP6. Senate report and that would have had a design improvement had indicated the B-70 engine had reached a point where high energy fans was no longer required to meet maximum range requirements—it added about 10% range while a single KC-119 refueling could add twice that range.

USAF cancelled the F-105 Mach 3 intercept program in September. North American was developing this airplane, and much of the aircraft and development effort was shared by the bomber and intercept program. This cancellation is estimated to have added \$180 million to the cost of the B-70.

On Dec. 3, 1970, USAF cancelled the B-70 weapons system program and requested all effort toward development of a single flight test prototype aircraft. Fiscal 1969 funds were cut from \$545.6 million to \$300 million, and \$75 million was allocated for Fiscal 1961, although Congress now has made an even \$300 million available. First flight was rescheduled from January, 1962, to December of that year.

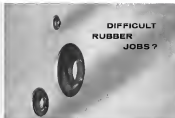
Discussing the advantage of using a two prototype approach under the present program cancellation, the Senate report pointed out that using two flight test aircraft would shorten the test program and the ground work involved and would result in elimination of insurance in case of an accident. Second vehicle could fly by April 1962 and would cut an estimated 16 months off the flight test program. Report said the second prototype would cost \$42 million to build, but that \$25 million used in a pilot test program would make its net cost \$17 million.

Senate group said that if the full B-70 funding appropriated for Fiscal 1961 were retained, cancellations, first flight would be made in December, 1962.

With adequate future financial support, the net SAC wing could be equipped by the fall of 1964.

AVIATION WEEK, August 6, 1969

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PROBLEMATIC RECREATIONS 26



As engineers constructing a model train layout (his was of course) wished to fence off two equal adjacent squares of a certain area. His available fencing was 2 inches short. However, by using 2 more squares of fencing, he was able to fence in the desired area in two squares. What were the sides of the squares?

—Richard Kenneth Matherly

The majority of rigid and flexible wireguide components in BMEWS bear the imprint of our Jackson Division. Why not test their capability in the field as your next early planning?

ANSWERS TO LAST WEEK'S PROBLEMS: ELYSIES was much too heavy. Zs are not white enough. He'll be 34.2.

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GSE

New in quantity production: Birkley Moore designed American Serving Trucks will help SAC's Hoisted Design equipped 8-Hill guard the peace of the 'Vile. Designed by a new graphic concept, sponsored by Wright Air Development Court and North American Aviation. CLM-77 granted support equipment like this: HDBA Education and Employment in the new business. HDBA and the 112 and when Birkley Moore engineering ability and product experience have been called upon for advanced reliable rescue support systems for aircraft and rescue.

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FINANCIAL

Aerospace Officers List Salaries, Stocks

Washington—Following is a list of aerospace industry officials' and executives' salaries and stock holdings for 1999 as reported to the Securities and Exchange Commission.

[illegible]

Germania Annual Reporting Corp.
E. M. Deering, chairman of the board,
divided \$5,000 salary and 100,000
shares of common stock. A. J. Smith,
president and chief, \$10,000 salary and 20,000
shares of common stock. M. F. Nelson,
vice president and general manager,
\$15,000 salary and 20,000 shares of com-
mon stock. E. C. Treadwell, treasurer,
president and chairman of the board.

The Komar Shovel Company—E. E. Komar, president and director, built the sawmill in 1946. The mill has a capacity of 100,000 board feet of lumber a year. The mill is located on the shore of Lake Umbagog, near the town of Newry.

[illegible]

Percentages of different types of fish species in the stomachs of *Chanos chanos* were not given, but a percentage of 441 species, *Chanos chanos* stomach and 11,841 that of *Chanos chanos* stomach of *F. chrysops* etc. 100 species of *Chanos chanos* and 171 species of *Chanos chanos* stomach. M. N. S. 100 species of *Chanos chanos* stomach and 100 species of *Chanos chanos* stomach.

only 1000–1500 copies of *Chlamydomonas* spores and 10–100 copies of *Chlamydomonas* spores in the water column. The water column of the lake was sampled at 100 m depth. The water column of the lake was sampled at 100 m depth. The water column of the lake was sampled at 100 m depth.

[illegible]

Following Shivers were and held a copy: Y. A. Johnson No. 150 (share of common stock); H. Waples No. 154 (share of common stock); R. W. Walling 159 (share of common stock); C. A. Kimes, 174 (share of common stock); M. J. Waples, 175 (share of common stock).

[illegible][illegible][illegible][illegible]

512, 5187 shares of Eastern Dynamite are now being sold at 1/32 share of Eastern common stock under that stock story per (5044) that J. E. McFarlane (president) is the corporation and owner 501331 shares and 51-1111 shares of common stock. J. E. McFarlane 504047 also president of Eastern Dynamite and president of American 5110-500 shares (sold by Columbia) which is listed.

STY. E. F. Alford, 5,000 shares of common stock and 1,000 shares of preferred in an electrical firm in another town in the "N. Star" State, 10,000 shares of common stock and 5,000 shares of preferred in another stock. **W. F. Stone**, 100 shares of common stock. **E. E. Finkbein**, 1,000 shares of common stock and 1,000 shares of preferred in an electrical firm in a nearby town. **A. M. Radford**, 400 shares of common stock.

[illegible]

11. Given $\vec{u} = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$, $\vec{v} = \begin{bmatrix} 2 \\ 1 \\ 3 \end{bmatrix}$, and $\vec{w} = \begin{bmatrix} 3 \\ 3 \\ 1 \end{bmatrix}$, find $\vec{u} + \vec{v} + \vec{w}$.

CAPABILITIES FOR DEFENSE



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If satellites and space vehicles stop "working", they are simply high cost space debris. Reliable power supplies are mandatory.

To meet this requirement, extensive Westinghouse research and development efforts are being applied to perfect reliable, compact, lightweight systems that will convert solar and nuclear energy into unfailing, long-life sources of electric power.

Westinghouse is investigating many new electrical power systems, but primary efforts are directed in six important areas. These are: 1. Thermoelectric; 2. Thermionic; 3. High-efficiency solar cells; 4. Photoemission; 5. Magnetohydrodynamic; 6. Rotating magnetic generation. This work is being performed by the Aircraft Equipment Department, Lima, Ohio, supported by the Central Research Laboratories and the Astronautical Laboratories, Pittsburgh.

Space power requirements—in not too many years—will be measured not in watts or kilowatts, but in megawatts. This need presents formidable technical problems.

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21000

Space

Moon, approx 100 miles



Spiral nebula in Cassiopeia



Spiral nebula in Virgo



Spiral nebula in Andromeda

Spiral nebula in Cygnus

Planetary nebula in Cygnus



Double star cluster in Cygnus



Saturn and ring system

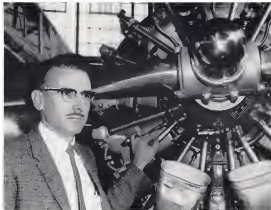


Head of Helix's Cloud

Waves in Sagittarius



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"AC Aircraft Spark Plugs deliver peak performance longer," says William Newton, Service Manager for Southern Airways Company. Southern Airways is one of the largest Beechcraft distributors—and "B" Newton, its widely recognized aviation engine expert, highly recommends ACs for these business and pleasure aircraft. The AC-588-BP spark plug, with AC's famous platinum electrodes in "Bolt" top choice for use in the R955 engine, power plants for the Beechcraft Super 815. "B" Newton recommends ACs for Beechcraft equipment because their longer peak performance runs downtime and stabilizes the normal schedule between engine overhauls. Why not take the lead from a man who knows aircraft engines? When it's time to change spark plug again—install an AC.

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BUSINESS FLYING



Beechcraft T44D and 440 owned by Luciano S. Richevich and operated by the Dondo Beach Hotel are parked in front of the hotel's hangar. Flown less often when maintenance is scheduled, the hotel's fleet gets owners with better flying opportunities for Puerto Rico. Aircraft leased for use in hotel's service during last year's December-April season.

Hotel Draws Business With Own Air Fleet

By David H. Hoffman

Donde, Puerto Rico—A 1,440 ft. paved runway and a fleet of three twin engine aircraft are proving useful components for the Dondo Beach Hotel, operated by 30 mi. of tropical forest from San Juan, Puerto Rico's capital city.

The corporate executives who host their business trips at the Dondo Beach Hotel began to look upon its unusual equipment in scheduling conferences and visiting plant sites across the vast Caribbean basin. Tourism, too, including the Beechcraft T44D and 440s and the Cessna 440 operated by the hotel is busy in commuting to and from San Juan and in island hopping to isolated Caribbean vacation spots nearby.

Executive Airline

Since December, 1958, when Luciano S. Richevich formally opened the remote hotel, at least 15 top U.S. corporations have flown their managers to Dondo for conferences or seminars. Many of the meetings are cosponsored by the company's owners, DCH and Gulfstream, by the former Aero Air Corp. center on the hotel property.

Often touching down on local air taxi, many start at San Juan International Airport by a hotel aircraft and ferried to Donde—80 mi. away by air.

Already this year more than 30 big companies—among them, Ford, Chrysler, IBM, Pepsi-Cola, Esso-Petroleum, and Hialeah Airlines—have

been proved convenient space in the 100-room hotel, where less than a mile separates their conference chambers from the runway.

Part-time runway bouncer Amos Eufonso is the second leg of his last flight, on which he disappeared in the South Pacific on his way around the world.

From sales, advertising and public relations offices in New York, the Dondo Beach dash directly with 2,000 travel agents in cities across the United States. It also works closely with the district booking departments of the airlines that serve Puerto Rico—Eastern, Pan American, Trans-Canada, Delta, BOAC, BWIA, Air France, Garuda, Iberia and Dominicana Airlines—offering discount rates to visiting companies and vacation groups.

Aware that the Caribbean competition for tourist dollars is growing better each year as more and more tourists reach the hotel still depends on its own facilities to keep occupancy rates about 90%.

Properly, the hotel plans to deposit airplanes or businessmen at the old Luis Grande Airport on the edge of San Juan's business section, less than 10 miles from Dondo by air and less than 30 mi. from downtown by bus.

To emphasize Donde's popularity last, Dondo Beach planes carried 1,455 paying passengers, logged 525 aircraft hours and added about \$10,000 to hotel income during last year's December through April tourist season. In that

period, the hotel's fleet, owned chiefly by Richevich, flew more than 21,000 mi. Weekends, at least, get so busy that the Green Shrike belonging to the hotel manager is in constant use supplemental service.

C. Richevich, general manager of the Dondo Beach, admits that the air department is not yet making a profit. But Richevich, a 51-year-old pilot himself, also wishes to operate his air unit's hidden value as an attraction and convenience for hotel guests, who often arrange charter even before arriving in Puerto Rico.

Following the hotel's charter service to San Juan, the most popular side trip at Dondo is to the bay port of St. Thomas, in the Virgin Islands, about 90 mi. away. Number one St. John Island, the Virgin Island National Forest and Grand Staircase, another resort developed by Richevich.

Informed to St. Thomas for winter recreation, a week, the service manager, Tom Richevich, owner, Dondo Beach guests who, for example, may spend the day at Grand Staircase. Deforest, after a quick excursion, the next plane flies toward San Juan to Dondo. When the trips are over in the evening, a ship is added at San Juan International for customs inspection.

Charter Rates

Charter rates range from \$68 (for the T44D) to \$110 (for the Twin Beech) to \$130 (for the Twin Beech) to \$140 (for the Cessna 440). Round-trip charter in the Cessna 440, the hotel's "middle-class" plane, are \$60. Cessna, 100 mi. and 500, Airplane, 250

HOW TO CHANGE HORSES IN MID-STREAM!



New Kinetics switch transfers battery power automatically in space craft



Part of the automatic transfer of battery power to reserve power source is made possible by the Kinetics switch which senses voltage drop and transfers power.

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The switch exhibits an output shutoff over the whole vibration spectrum, from 5 to 2000 cycles, 40 G's. Voltage drop sense typical switch on, time is less than 10 milliseconds at 20 steps. No power is required to hold the switch open or closed. High density construction permits its duty in 21 days at less than 10 milliwatts. An ultra-sensitive electronic neural monitors battery voltage. When the second voltage falls to a pre-set level, the circuitry passes current to the

switch motor, causing power transfer. It may be applied to systems where a switch is needed to transfer battery power after shut-out of ground power. After launch, when the main is in, the switch transfers the battery to the main. For systems employing more than two batteries, additional switches can be added for preprogrammed or automatic power change over.

For any switch application where absolute dependability under shock environmental conditions is essential, write or phone Kinetics Corporation, Dept. K-10, 419 S. Collins Avenue, Solon Beach, Calif. 94068 (415) 535-1100.



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ms. and 5258, Cradell Flight 100 ms. and 5403, and Parker Phase, 559 ms. and 5410.

When the Doude North aircraft spent 18 months ago, it had the 2200-watt outboard motor, a one-cylinder steel engine. The outboard engine General 162 to work with. Under Thomas G. Loh's the airport manager who came to Doude from Atlantic Aviation Corp. in New York, it is estimated a \$15,000 spare parts inventory. Today, with a six-cylinder outboard motor and the department experts and repair its expanded in fleet in necessary.

Loh also installed reverse lights, an illuminated stall cone and a Nitro V10. Unconform to most airport officials. The company, he reports, refers when approaching Doude North Doude North operations on 1238 are to arrange at low level for airported guests of the hotel.

The airport, having close approaches of each end of its runway, also offers 100 action graphics, Douglas DC-3 landing strips and a firefighting Aerial Jeep. No landing fee is charged.

A departures ramp for the Doude Doude is operating in the road connecting the hotel's 1,500 acres with the city of San Jose and its airport, about 10 mi. further to the east. Low-levels make the trip in roughly an hour, crossing considerable not quite enough to compensate for drop rate in the road. During January, a typical month, 190 guests fly in from San Jose on Doude North planes, but 700 depart to Doude as they approach, most of the rough ride in.

Engage in 1970

The present Doude airport had its beginning in 1970, when Clara L. Engage, a power engineer, entered a given landing strip from the surrounding grassland plantation she had inherited from her father. She had a small plot of land on a few acres before-coming of the old Castro-Wright Schoolhouse in Valley Street, Long Beach, N.Y.

In 1971, with her own's a partner, Mrs. Engage has, for three-plus years, to Doude North. Accompanied by her contractor, she has spent over a long, hard day at Doude. First of the first two buildings, 536 to house the first, constructed a half dozen students before it collapsed.

On June 1, 1977, Anita Furbert and Fred Newman, by engineer, landed their Lockheed T-38A Laboratory at Doude in the Kingston plantation house, they spent the first night on a light bed, but it needed construction, would have been the first plotted by a woman to make the globe landed, the two women

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THE PROBLEM SOLVERS



Rockets to probe the Van Allen belt

Aerolab engineer checks guidance line for the ARGO D-8 rocket that will boost a nuclear-motivated recovery vehicle (NERV) to 1500 miles altitude to study the Van Allen radiation belt. As probe reenters to NASA, Aerolab engineers must also plot precisely the ballistic trajectory and impact point of this unguided rocket so that the nose cone may be recovered from the ocean 1700 miles down the Pacific Midline Range.

Aerolab has developed nose cone probes and rocket-powered research models, including the Mercury capsule model, which have been used.

than any other done in the United States.

Currently, Aerolab, a wholly-owned subsidiary of Ryan Aeronautical Company, is developing instrumentation packages, attitude and stability controls for payload packages, particle collectors, payload recovery systems, antenna arrangements, and nose cone separation devices.

Then, from the complete package in which Aerolab has experience for the entire program, to the provision of submersed components, the problem solver at Aerolab has capabilities in aerophysics beyond the usual.

RYAN OFFERS CHALLENGING OPPORTUNITIES TO ENGINEERS

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Pasadena, California San Diego, California

prominently crashed on July 2 with 500 gas killed.

Nasman, a former station manager for Fox American World Service at Port-of-Spain, Haiti, had been a close friend of Miss Livingston.

After serving as a flight instructor during World War II, Miss Livingston returned to Ecuador in 1947 to engage her first husband. The meeting, which she had learned to the Army Air Corps in 1945, had been painful and tough.

Two years after the flight school closed in 1951, she sold the first 150 acres of her tropical plot in MacArthur but kept a residence on the property. Granted landing rights for Mr. Miss Livingston, a retired and commander of the San Juan Civil Air Patrol unit, she allowed debris to her San Juan headquarters in a single engine Nasman.

PRIVATE LINES

ON 70,000 civil aircraft reported with FAA, 8,751 are registered in Colorado. States with the next highest number of active registrations are Texas, 6,137; Illinois, 5,751; New York, 5,144 and Ohio, 5,139, according to FAA publications. "U.S. Active Civil Aircraft by State and County."

Continental Aircraft Engineering Corp., Inc., Ag-Cat 8-995 in Uruguay in the Andes Mountains to deliver the significant legions to the Lufthansa Co. Another Ag-Cat was flown 2,400 miles to Puerto Rico for Hispania Airways, Inc., operates a sugar cane plantation there.

Two Beech Model 55 Queen Airc have been delivered to the Venezuelan Air Force, planes now purchased by the Ministry of Defense through William C. Morales & Co., Beechcraft distributor at Caracas. Two more Queen Airc will be delivered to the police and reported Civil flying school for use in target engine training.

New terminal building and control tower has been completed at the University of Illinois airport at Urbana, Ill. Construction was started on a new hangar for business aircraft having airport is operated by the University's Institute of Aviation.

Hubo Search & Rescue Unit, a unit of the Idaho State Department of Aeronautics, has issued its 7th edition of the state's air map and its companion publication, the Airport Facilities Directory, according to Chief Warden, Rowe, department director. Map is under being of fourteen facilities in aviation and



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of ground radar

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Several new contracts for research and development of computer and guidance components for the Polaris Missile have recently been awarded to the Hughes Engineering Division. As a result, a variety of openings have been created for graduate engineers and scientists who have a minimum of three years experience specifically related to:

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WHO'S WHERE

(Continued from page 23)

Changes

Donald E. Roberts, manager research and product planning, Whittaker Controls Division of Telecommunications Corp., Los Angeles, Calif.

William Swank, assistant sales manager, Fuller Steel Co., Cleveland, Ohio.
Richard B. Feltner, manager, The Gravity Corp., Aircraft Manufacturing Division, Los Angeles, Calif.

D. G. Wilson, manager of the Los Angeles (Calif.) plant, Aero Industries Division of Avco Inc., Division of Aero Industries Corp., and **J. R. Kra**, manager of the Los Angeles (Calif.) plant.

Dr. Van W. Brainerd, director of research, Minneapolis-Thomson, Raytheon Co., Minneapolis, Minn., and **Dr. John N. Donaghy** and **Edward E. Kren**, assistant research directors.

E. G. Erickson, director of engineering, Capital Airlines.

William S. Mares, director of engineering, Thompson-Ramo-Woodbridge Products Co., Northridge, Calif., a division of Thompson Ramo-Woodbridge, Inc.

E. W. Fife, director of electronic program development, Defense Contracts Division, Aero Industries Corp., Falls, Pa.
Dr. William C. Schaefer, Washington, D. C., representative for Systems Development Corp.

Thomas E. Cline, director of all visual studies, International Research Machines Corp., New York, N. Y.

Lyle A. Jakes and **James C. Brown**, senior associates in the newly formed systems laboratory, Hughes Aircraft Co., a general systems group, Torrance, Calif.

Melvin Cohen, head of the newly established Washington, D. C., technical liaison office of General Technology Corp., a subsidiary of General Systems Corp.

Gilbert A. Hageman has joined the technical staff of Norwood Engineering Science Co., Pasadena, Calif.

Leonard A. Koval, director of engineering, North American Corp., Van Nuys, N. Y.
Mr. Donald R. Robertson, senior manager, Dr. Stanley Gaudin, head of the Chemistry and Air Research Department, Vane Laboratories, West Orange, N. J.

Richard L. Booth, chief of light test facility, Hughes Co., Seattle, Wash.
C. Harold Hanna, director of research, Motorola, Phoenix, Arizona, Inc., Tempe, Ariz.

Robert T. Jones, director of International Operations for Aerotronics, a division of North American Aviation, Inc., Downers Grove, Ill.

Norm J. Toporens, system design team agent, Systems Management Department, Electronics Division of Armstrong-Corona, a division of General Dynamics Corp., Rockville, N. Y.

Thomas C. Prohman, chief engineer, Radio Science Corp., New Haven, Conn.

Dr. Arthur Goldsmith, director of engineering, Wilco Electronics Corp., Inc., Kansas City, Mo.

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AVIATION WEEK, August 6, 1960

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PUBLISHED BY THE FLIGHT PROPULSION DIVISION OF
GENERAL ELECTRIC IN CINCINNATI, OHIO / AUGUST, 1960

FPD NEWS offers broad information on openings throughout the Division to industrial engineers and scientists, technical administrators and those seeking to further projects with the support from General Electric resources.

New Fan Burner Engine Proposed for 2000MPH Speed Range

Recently the general manager of FPD, J. B. Montgomery, announced that 2000 mph military and commercial transport aircraft can be powered efficiently and reliably by a new type of jet engine which FPD is presently developing.

Called a fan burner, its principle involves burning fuel in the exhaust of a fan mounted directly behind the hot jet engine. From its operating point of view, the manager declared it would also be possible to

apply this principle to an existing engine such as G.E.'s F4U, powerplant designed for the F-105.

Then development of an interesting example of Flight Propulsion Division's going up for the unique requirements of commercial jet powerplants over the next decade. In this case, the Division is "building from scratch"—beginning new programs for industry as its experience and continuing research in combat aircraft powerplants.

Broader Scope Envisioned For New FPD Jet Engines



Within contemplation of the type of jet and under development by General Electric's FPD is a program to use its jet engine technology in the area of engineering and product application. Only will be given to FPD about 200 jet engines operating at 20,000 rpm. Called a fan burner, the engine is designed to operate at 20,000 rpm.

Envisioned Scope Envisioned in Military & Commercial Jet Engine Development and Design

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FLIGHT PROPULSION DIVISION

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LETTERS

British TBO Comment

We're interested in the current U.S.A. debate about FAA's proposals to reduce engine overhaul (TBO) May 2, p. 45 and May 9, p. 35).

Regarding the proposal described in the May 9 article, maintaining then, if the right engine failure rate has changed, the best choice would, then, be to alter the left-hand column of the following table, then the true between overhaul (TBO) is affected as shown below:

Left-hand failure rate and true engine failure rate	Actual
Less than 1.0	Decrease engine TBO to 100 hr. Decrease economy TBO by 500 hr.
Greater than 1.0 but less than 1.5	Decrease engine TBO to 100 hr. Decrease economy TBO by 500 hr.
Greater than 1.5 but less than 2.0	No change
Greater than 2.0	Increase engine TBO by 500 hr. Increase economy TBO by 500 hr.

In flight failure is defined by FAA as any loss of power or thrust, or inability to run but it, while the aircraft is airborne. Failure due to failure after start requires the loss of required "Accuracy" means those essential accessories without which the engine cannot be started, or run.

It is assumed that the rate is proposed in the table that it will help to prevent any accidents and incidents due to engine failure. Changes in the TBO of an engine will, however, only significantly affect the number of accidents or incidents if a change in TBO results in a significant

change of the right-hand failure rate. Very little information, if any, appears to have been published on the subject. In the absence of such information, it is not possible to say what effect upon aviation safety the proposal would have.

It is known, however, that some turbine engine failures are due to causes which do not share any connection with the life of the failed component or of the engine, either next year, or next overhaul.

Changes in the TBO will not affect the frequency of such failures. This is what is used by FAA in the case of failures due to fatigue cracks, since such failures can be excluded from the total. It would seem equally reasonable to exclude any other failures which are shown not to be affected by life. In order to assure the improvement in maintenance of the rule came into force, the facts about the relationship between the TBO and failure rate from past experience should be published and studied.

Limited information available to the writer shows that on a particular large turbo-prop engine, a change of 500 hr. in the Air Registration Board-approved TBO of 2,000 hr. affects the failure rate by 5%.

Changes in the TBO of an engine will not affect the failure rate if the failure rate of an engine is 2.0 per 10,000 engine hours, then lie a three hour flight at a four engine aircraft, the probability of having a failure of one or more engines is 2.2 in 1,000,000 flights (The probability of a single engine failure is not dealt with because all transport aircraft have to be capable of one flight after failure of a single engine at any stage of the flight). If the engine failure rate is reduced by 1% then the probability of a multi-engine failure falls from 2.2 in 1,000,000 to 2.0 in 1,000,000.

Such a change, in a probability which is already very small indeed, would not appear to be a significant one.

The rule is, it is suggested, only warranted in those cases for which the proposed changes in TBO would have a much

greater effect upon the failure rate than in the example quoted.

There is another potential aspect of the matter which will bear examination. It is great concern with a certain probability, that is, an average of seven in ten every month, or year-on-year, 2.0 times every 10,000 engine hours, it will not occur nearly 2 times at each week, month, year or 10,000 engine hours. The probability that it will occur exactly 2 times, and other numbers of times, may be determined from the Poisson distribution, which says that:

If the "expected" number of occurrences of an event is λ , then the probability that the event will occur k times is given by the equation:

$$e^{-\lambda} \frac{\lambda^k}{k!} = \frac{e^{-\lambda} \lambda^k}{k!} \quad (1, 2, 3, \dots)$$

This distribution is derived from considerations of mathematical probability. More important to engineers, when it is applied to certain practical cases, the Poisson distribution is observed, usually very well. This has been found to apply to gauge used by a nuclear team, failures of electric light bulbs, number of defective items in a batch, deaths from bone cancer of U.S. servicemen (1920-1950), and accidents, turbine blade failures, and many other events which maintain a given average value, but vary over extended areas of time or number.

For an expectation of 1.0, the probability of various numbers of occurrences is given below:

	Expectation of 8							
Actual No. of events	0	1	2	3	4	5	6	7
Probability of this number	0.37	0.37	0.14	0.09	0.05	0.03	0.02	0.01
Actual No. of events	8	9	10	11	12	13	14	15
Probability of this number	0.01	0.02	0.03	0.05	0.09	0.14	0.37	0.37

The probability of having exactly eight occurrences is 7%, that is, we would only get exactly eight 14 times out of every 100. On three out of 100 occasions, we would get three occurrences only. On one out of 100 we would get 14 occurrences. The probabilities of such numbers rise up, of course, to 1.00, which means that one must occur each time.

Let us apply this to a fleet of aircraft. Suppose we have 15 aircraft, each averaging 1,535 hr. per year. This gives 50,000 aircraft hours per year, or 10,000 engine hours per three months. Suppose the average number of shutdowns per three months is eight, represented by a rate of 1.6 per 10,000 engine hours. The probability of various actual numbers of failures, the corresponding rate, and the error in TBO which would be taken under the proposed rule are tabulated in the list.

Where the rate falls exactly on one of the boundary figures proposed by FAA, the most adverse effect on TBO has been assumed.

(Continued on page 130)

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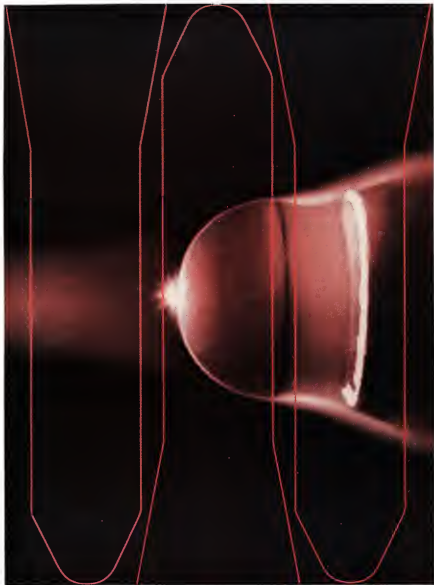
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